THE

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ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

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MORE MUNICIPAL TRADING.

THOSE who read accounts in the newspapers of the wrong-doings of local authorities are often at a loss to know what remedy is open to those who suffer from an alleged breach of trust on behalf of municipal bodies. It is a maxim of the law that there is no wrong without a remedy, that where rights of property have been interfered with, the law will step in and give compensation to those whose property has been injured. The ratepayer pays his rate, often with a grumble, frequently unwillingly, but he seldom or never inquires into the purposes to which that rate is to be devoted. We shall draw attention presently to an anomaly of our present rating system, which in effect prevents many ratepayers knowing that they are rated at all, and which also prevents them from ascertaining the amount of their rate. Small wonder, then, that these persons, who form a very considerable portion of the rate-paying community, should be indifferent as to the destination of the funds to which they subscribe; and it is part of the duty of those who look with dismay upon the increase in local rates all over the country to draw attention to any breach of duty which is committed by rating authorities.

But supposing the ratepayer ascertains that the rates which he is paying are being used for an unlawful purpose, what remedy can he invoke? Has he the power to bring an action against the rating authority for breaches of trust, for that is really what it amounts to? It appears that he has this power; but it is a power which can only be exercised at great expense and at grave risk to his own pocket should he be unsuccessful in his appeal to the Courts of Justice. The Court may intervene to prevent the doing of an act by any Corporation which is *ultra vires*. For instance, a local authority could not without statutory power establish a system of tramways. It could not, if it already possessed a system of tramways worked by electric power, use any portion of the electricity generated for the purposes of the tramway for supplying electric light to the public.

In a recent case an important question has arisen as to what is within the power of a tramway company. The case of the Attorney-General *v.* The Lord Mayor and Citizens of Manchester, which is reported in our other pages this week, illustrates two things:—(1) That a local authority must pay strict attention to the statutory limits which are imposed upon it, and (2) that where those limits are exceeded a ratepayer who is affected may appeal to the Court for protection. In this case there arose one other point to which we should draw attention, namely, that although the plaintiff was successful in showing that the Corporation of Manchester had exceeded their powers, he was nevertheless deprived of part of the costs.

The facts of the case may be stated in a very few words. The Corporation of Manchester own certain tramways within the city, which are worked under statutory powers.

They also lease certain other tramways in the neighbourhood. On all these tramways they have power to carry passengers and to carry parcels. In connection with their parcel business they have established depôts, provided horses and carts, and undertake the delivery of parcels, not only by means of the trams running on their tramlines, but by means of horses and carts which carry parcels from place to place wholly independent of the tramlines. The plaintiff in the action is a carrier in the district. He therefore naturally felt the stress of competition, and sought to restrain the Corporation from carrying on the business of a common carrier. Mr. Justice Farwell held that in so far as the Corporation carried parcels on their lines and delivered those parcels to persons living near the tramway or collected parcels for the purpose of conveying them on their tramway, they were acting within their powers, but he came to the conclusion that the Corporation were not entitled to carry on the business of carriers independently of their tramway, and that the Court would interfere to prevent the expenditure of the borough funds on such a venture. "It is obvious," he said, "that a delivery service by carts to and from villages not connected with the company and a general agency for all railway companies must entail expense, even if the same carts and men be used as are employed ordinarily in tram service proper. I cannot believe that a large general delivery service and a general railway agency can be added to the service limited to communication with the trams without expense." In the end he made a declaration that the Corporation were not entitled to act as common carriers, but in view of the fact that the plaintiff had only succeeded as to part of his case (for he had disputed their right to collect or deliver goods at all) the learned judge only awarded to the plaintiff half his costs against the Corporation.

Dealing first with the law of this decision, we confess that we find it a little difficult to understand, having regard to certain previous decisions. The powers of the tramway company incident to the conveyance of parcels, provided that the trams might be used for the purpose of conveying and delivering parcels amongst other things. Does such a power enable the Corporation to collect parcels at people's houses and to deliver them elsewhere? In the case of the London County Council *v.* Attorney-General, which was heard in 1901, it was decided that the County Council could not carry on the business of omnibus proprietors by virtue of their statutory power to run trams. By the London Tramways Co., Ltd., Act, 1896, Sec. 31, the County Council were empowered to buy the tramways and any works and property connected therewith, including therefore the omnibuses and horses, and, further, it was argued that they were impliedly authorised to work the omnibus traffic. This argument, however, did not prevail. In giving judgment in the House of Lords, Lord Macnaghten said: "The London County Council are carrying on two businesses—the business of a tramway company and the business of omnibus proprietors. For the one they have the express authority of Parliament; for the other, so far as I can see, they have no authority at all. It is quite true that the two businesses can be worked conveniently together, but the one is not incidental to the other." In effect, therefore, the House of Lords has held that the bringing of passengers to the tramway terminus by omnibus is not incidental to the business of the tramway. Why, then, should it be incidental to the business of tramway company acting as a carrier of goods to bring those goods to and from the tram? This point is one which may be taken if the case under consideration goes further.

We have pointed out that this decision is of importance from the point of view of those who are opposed to municipal trading. In this instance the fact that the Corporation of Manchester were exceeding their powers, was brought home to one who acutely felt the stress of competition. We should be interested to see a table drawn up showing the powers which are exercised by local authorities in all parts of the country. Would the case of Manchester be the only instance in which statutory powers are being exceeded? We know only too well that in carrying on the business of electric light supply, many corporations and other local bodies are only too apt to exceed their powers. The case to which we have referred is given in illustration of the fact that if it can be shown that these powers are being exceeded the Courts would intervene. Doubtless the remedy is costly, but if those in the electrical trade were to combine together in their capacity as ratepayers in any particular district, we venture to think that the abuses, as to which there is often such loud complaint in these columns, could be lessened.

One word as to the general attitude of the ratepayer in these matters. We have pointed out in an earlier part of this article that there is a large body of ratepayers who are practically indifferent to an increase in the rates. Many rating authorities adopt the principle of compounding; that is to say, instead of collecting the rates themselves they accept 80 per cent. from the landlord of a group of tenants, and allow him to collect the full amount from his lessees. Under this system, if the rates are increased, the tenant thinks that the landlord is putting up the rent, and he is indifferent, not only to the increase in the rate, but as to the object to which that rate is to be devoted. Under these circumstances, it is not surprising that there should be apathy on the part of ratepayers in this country.

Canals.

Though our contemporary, the *Engineer*, has not given encouragement to the idea of canal reconstruction, a series of articles on canals, ancient and modern, has appeared in its columns. Canals in France were constructed long before any serious work had been done in this country. Thus the canal of Languedoc was projected in 1666 and finished in 1681. This canal was carried over rivers, and under a hill by a tunnel 720 ft. long, and its depth was 6 ft. The disbanded French soldiers in 1782, after the American war, were employed in canal construction. English canals began by the improvement of rivers, and in 1755, in place of improving the Sankey brook, the promoters cut a canal and avoided the bed of the brook altogether; this canal was made about 1760. It is noteworthy that the great canal works were altogether carried out by private enterprise, just as were the great railway enterprises that followed. When industry has been left to private enterprise in this country it has best succeeded, and what is wanted to-day is such freedom for private enterprise as will encourage the expenditure of private capital without fear of enmity on the part of municipal extremists who affect to look on all private enterprise as next door to

fraud. When the methods that seem to be inseparable from the municipal control of industry are seen in all their fatuous ignorance, it is impossible to regard any further spread of this envious spirit with equanimity. There is a great work yet to be done in England in respect of the canals, and it is much to be hoped that Parliament will take such steps as will give some assurance of profit to any undertakers who will be so public-spirited as to come forward and undertake this duty.

Running Expenses of Electric Railways.

It appears from the report of the Lancashire and Yorkshire Railway Co. just issued that, after a full year's experience of electrical working on the Liverpool and Southport section, and after making proper depreciation allowances on the more costly plant as compared with ordinary steam plant, the cost per train-mile run is slightly higher. The chairman went on to say that with this the directors were quite satisfied, because they had been able to do a much greater amount of work, and to give a very much improved service to the public—a service which would have been absolutely impossible under the old conditions. Additions are now under consideration to enable the rapidly growing traffic to be dealt with as it arises. Large additional numbers of passengers have been carried over this electrified section of the railway, and this growth is particularly noticeable in respect of the short-distance traffic. The chairman spoke of the whole system working smoothly and well. The published accounts of this company show that it possesses 39 electric cars.

There is nothing in the report to show whether this electrified section of the railway has been debited with any dead capital in the shape of obsolete steam locomotives and carriages. We should say not, and herein lies the advantage possessed by a large railway when it proceeds to electrify a short section of its line. The rolling stock of a railway is constantly being depleted by accident and the natural decay to which it tends, and when the time comes to electrify any portion of the line, a certain proportion of the scrapped rolling stock of the whole line is not renewed as steam stock, but in the shape of electrical stock. No capital has to be written off as obsolete. This writing-off of capital in the shape of cars, horses and track has been a serious load on electrified horse tramways from which the steam railways are able to free themselves by the more gradual way in which they are able to undertake the change.

A railway whose rolling-stock is scrapped at the rate of x per cent. yearly can afford without inconvenience on rolling-stock account to electrify x per cent. of its system annually, leaving only the cost of track equipment and power plant to be dealt with as new items.

Tramway Troubles.

In our leader last week we commented upon the disagreement between the London United Tramways and the Ealing Corporation, as disclosed by the report of Col. Yorke to the Board of Trade, and that of Mr. Jones, the borough surveyor, to his Council. We regret to find that our remarks have been regarded as a personal attack upon the engineer and managing director of the company, Sir J. Clifton Robinson. Needless to say, this was not our intention, and it had not occurred to us that our article would be so construed.

It appears that the reports in question afford a merely superficial view of the matters at issue; we are informed that for years past—indeed, from the very commencement of the conversion of the tramways to electrical working, and their consequent extension—the leading residents and officials of Ealing have carried on a bitter warfare against the company, and for several years they succeeded in thwarting the plans of the latter, leaving Ealing isolated in the midst of a network of tramways. Our readers are well aware of the campaign of extortion which has been consistently carried on by the numerous local authorities with which the company, to its sorrow, has had to negotiate, and it was only by consenting to widen the roads and to effect other improvements that it obtained the assent of the then U.D.C. to the construction of a tramway through Ealing, to link up with the light railway running out to Uxbridge. We understand that more trouble has been experienced by the company in connection with the two miles of tramway in Ealing than in the whole of the remaining sections, embracing nearly 50 miles of route.

The reply of Sir J. Clifton Robinson to the Borough Surveyor's report is published on another page of this issue. We note that the latter is again complaining to the Council, this time on account of the repairs which are being effected on the tracks; obviously, as cars are running 22 hours out of the 24, it would be impossible to relay the track, even if this were necessary, without stopping the traffic, and repairs must be carried out piecemeal during the day. The intention is apparently to hamper and worry the company, no matter what it may do, and therefore the charges brought against it must be heavily discounted.

Fire Protection in Telephone Exchanges.—In a recent issue of the *American Electrician* Mr. H. S. Knowlton contributes an article on Fire Protection in Telephone Exchanges. The risks of fire are due to external rather than to internal causes, and so far as the telephone exchange itself is concerned, there is no power generation on any large scale, there are no high voltage problems to deal with, and all the wires carry low voltages. In the telephone business there is a great tendency for rubbish to accumulate, on account of the thousands of individual pieces of equipment used in central office work. These parts are generally carefully packed, and the disposal of packing cases and boxes is a matter of some importance.

The point of greatest danger from external sources is in the operating room behind the switchboard. Windows are usually provided in the walls behind switchboards in order to give ample light for inspection and repair work, and he suggests that wired glass and metal sashes should be used in such positions.

One element of fire risk is in the use of soldering-iron heaters. These should be provided with non-combustible supports. Gasoline torches are frequently set on operating room floors in the most promiscuous fashion. It is suggested that electrical soldering irons would be much safer. In a properly designed exchange there should be practically no use for matches at all. Next to the careless use of matches comes the careless use of tobacco in workrooms, storerooms, lifts, &c., and to combat this there should be no combustible waste baskets in a telephone office.

As regards apparatus for extinguishing fires, there should be a liberal supply of fire pails, sand buckets, dogskin gloves, asbestos or woollen blankets; and, to protect the apparatus from injury due to water, waterproof covers should form part of the exchange equipment.

The use of water about the switchboard is deprecated; compressed carbonic acid gas extinguishers are preferable. Dry powder extinguishers or bellows filled with such powder are very useful in such places as halls, lavatories, &c. Sand buckets should be used in the following proportion:—One bucket in the terminal room, or at the main distributing frame; in the operating room, one near the head of the board, and one for each five sections. Corrosive solution must never be used about the switchboard, desks, &c., except when all other available means have failed. Each 10 sections of the switchboard should be provided with asbestos blankets, and a useful size is about 36 in. sq. These are particularly useful in putting out fires due to high-tension crosses.

To avoid damage by water, cables should be run at least 4 in. above the floor level; where these run through floors, there should be a galvanised iron guard all round, high enough to prevent water flowing through. Such openings should be preferably covered so as to prevent draughts of air from carrying the fire from one floor to another.

It is not an uncommon thing to find fire pails only partly filled, and it is good practice to refill these at least once a week. Extinguishers also should be discharged and filled at least once in 12 months; valves and hose should be tested at least once a week, and fireproof doors and shutters should be tried regularly to ensure that they are in good condition. Thermostat alarms in out-of-the-way corners of the plant are advisable, and asbestos fireproof barriers should be installed between the cord shelf and the multiple jacks on the switchboard. Regular fire drill should be instituted in offices where the operating room is on the second floor or higher.

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ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL PROGRESS IN 1905.

By F. S. SPIERS, B.Sc., A.M.I.E.E.

Introduction.—Progress in scientific industries may take place in one or both of two essentially different ways. On the one hand, new applications of science may bring about the establishment of a new industry, or may introduce into an existing industry fundamentally new methods of procedure—such changes, in fact, as would be styled "revolutionary" anywhere but in a level-headed technical Press—and, on the other hand, the stimulus to progress may be brought about by the ordinary operation of economic laws, increased demand, and therefore increased output and diminished cost of production, improved internal organisation, new sources of raw material, and the thousand and one improvements in details of manufacture which every healthy industry is continually introducing. Both of these methods have operated to bring about the steady and satisfactory progress that has been made during the past year in those metallurgical and chemical industries in which electricity plays the all-important part. The most striking and important illustrations of the first method are the electric smelting of steel, the fixation of atmospheric nitrogen, and, to a less degree, the electric refining of lead. Illustrative of the second method, the normal expansion of established or semi-established industries, are the electrolytic refining of copper, the manufacture of aluminium and of refractory electric furnace products, and finally the growing use of electrolytic bleach and of hypochlorites and ozone for the purposes of disinfecting sewage and sterilising drinking water. In discussing these developments in some detail, it will perhaps be most convenient to treat first of the metallurgical side of the subject, and finally, in a third article, to discuss briefly the electro-chemical industries which are concerned with manufactures other than the smelting or refining of metals or the production of their derivatives.

Iron and Steel.—Here the progress has been real, and there can be no doubt that given the proper conditions, electric smelting has come to stay. As far as this country is concerned, the conditions have been clearly stated by Mr. F. W. Harbord, and they have been practically accepted as correct by all the experts who have given the matter consideration. For some time to come electric smelting in England must be confined to the "manufacture of special alloys of high-class tool steel, and, in some few cases, for special steels at present made in the Siemens furnace." It is as an adjunct to the converter or the Siemens-Martin furnace that the electric furnace must be looked for in the immediate future. No experiments of a considerable nature have as yet—as far as one knows—been carried out in England, but furnaces of the Kjellin and Héroult types are said to have been installed in Sheffield, and it is gratifying to note that Prof. Arnold is erecting a Kjellin furnace, of 1 ton per day capacity, at University College, Sheffield, for the purpose of making a comprehensive study of Kjellin tool steel, as compared with the ordinary crucible product. Elsewhere progress has been more marked. M. Héroult himself has been particularly active—4,000 tons of steel have now been made by his process. During the year he was erecting a "mixer" of 300 to 400 tons capacity, which was to be fed by five or six Bessemer or Siemens-Martin furnaces. The "mixer," in the case of steel, was to be heated electrically, its object being to secure uniformity in the product of an entire works. From the "mixer" the metal was to be fed into a 50-ton furnace to be refined as necessary. Seeing that the largest charge hitherto smelted in an electric furnace has been about 4½ tons, it will be seen that the advance is a very real one, and great economies are to be expected; M. Héroult has already reduced his energy consumption to 0·15 E.H.P.-year per ton of steel, using scrap as raw material, and to 0·0114 E.H.P.-year, starting with the molten metal.

From America, where for some months past M. Héroult has been explaining the advantages of electric smelting, considerable progress is reported. At Syracuse the Halcomb Steel Co. is installing an 80-ton per day Héroult furnace. At Sault Ste. Marie an experimental Héroult furnace yielding 2 to 4 tons a day has been erected, with the co-operation of the Canadian Government—whose statesmanlike foresight in this direction cannot be overpraised—for the smelting of pig-iron from Lake ores. The experiments now under way will be continued for some months; their results will be awaited with eager interest by all metallurgists. At Guadalupe, in California, 600 lb. of steel have been made electrically direct from the local ironsands, and a large furnace is being constructed to tackle the problem on a commercial scale. While on the subject of ironsands, we may refer to the Galbraith-Stewart process for smelting New Zealand ironsands, which was somewhat prematurely demonstrated at Loughborough last summer. The promoters are now continuing their experiments, it is understood, in America, and as they are on the right track, they will doubtless succeed. The ironsand problem is sure, at last, to be solved electrically. In May it was reported that the first steel ever made in America in an induction furnace had been produced in the Colby furnace. There is, perhaps, a slight obverse to the medal; the Ruthenburg Reduction Co. has for the present ceased operations, although work is, it is said, shortly again to be resumed under new management. The Ruthenburg process, it will be remembered, was an agglomerating and a fritting rather than a smelting process.

Passing to the Continent, we find that at Gysinge M. Kjellin is installing a 736-KW. furnace to replace the present unit of 170 KW. With the new furnace he hopes to reduce his energy figures from 770 to 590 KW.-hours per ton of steel, starting with cold pig, and from 650 to 490 starting with molten pig. M. Kjellin is now stated to be producing 1,500 tons of high grade steel per annum. At Unieux Messrs. Holzer are installing a Keller-Leleux furnace for refining open hearth steel, from which 8-ton ingots—for guns—are to be cast. The Héroult plant at La Praz, previously referred to, is being enlarged to 13,000 H.P., and that at St. Michel-de-Maurienne to 6,000 H.P.; very soon 3,000 tons of tool steel, besides ferro-alloys, will be produced annually in the Héroult furnace. M. Girod has now in operation two plants, 4,000 H.P. in Switzerland and 8,000 H.P. in Savoy, for the manufacture of ferro-alloys. He is the largest producer of ferro-tungsten in the world. M. Girod is experimenting with a new type of steel furnace, the special feature of which is the cooled lower electrode fixed in the masonry of the furnace bottom. The Gin resistance furnace, which has not up to the present been tried on a practical scale, has been erected at Plattenberg, but no results have as yet been published. Mr. W. McA. Johnson has been working at the electrolytic refining of iron in aqueous solutions. Promising results have been obtained, but no opinion can as yet be expressed as to the practicability or the use of such a process.

Ferro-Alloys.—A quite unnecessary halo of mystery, on the part of inventors, manufacturers and users, seems to have been allowed to gather around the newer ferro-alloys which are now slowly coming into somewhat extensive use, and the result is that no very satisfactory information on their special uses is as yet available to any outside the inner magic circle. Possibly the devotees of the various brands on the market have conscientious objections to pressing their claims with too much vehemence; one fact is, of course, certain—every new ferro-alloy is far more effective, and, therefore, cheaper than all its predecessors. A few weeks ago Dr. O. J. Steinhart read a paper on the subject before the Institute of Mining and Metallurgy, and in that he has collated most of the available information. Messrs. Keller, Leleux & Co. are now operating a 600-H.P. plant at Kerrouse, and a 15,000-H.P. plant at Livet, and their present output is 250 tons per month of 25 to 75 per cent. ferro-silicon, 150 tons of silicon-spiegel (38-40 per cent. Mn, and 22-24 per cent. Si), and 80 tons of ferro-chrome. The Willson Aluminium Co. has a monthly output of 200 tons of ferro-chrome. The Beaver Metallurgical Co. have just completed a plant at Beaver Falls in Pennsylvania for the manufacture of rare metals and their ferro-alloys. Recently, in America, pure silicon, free of iron, has been produced in the electric furnace in commercial quantities by reducing silica with carbon or calcium carbide. Of late years ferro-vanadium and ferro-titanium have had their respective votaries, but no really decisive tests can be

looked to yet to decide once for all the value of these fancy additions to steel. The latter, produced by means of the alumino-thermic reaction, is supposed to prevent pores in steel castings, and it is claimed by those that use it (who ought to know) to increase the elasticity of their product.

The Utilisation of Blast-Furnace Gases.—Indissolubly bound up with the economic aspects of electric steel smelting is the question of utilising blast furnace gas as a cheap and ready source of electrical energy. When it is stated that the proper utilisation of these gases would be equivalent on a moderate estimate to a 10 to 20 per cent. increase in the output of a blast furnace, the importance of the subject to the electro-metallurgist may be realised. Europe is in this respect *mirabile dictu* actually more advanced than America, for on this side of the Atlantic no less than 200,000 H.P. is being derived from blast-furnace gases. In the States such available power amounted in 1904 to over 900,000 H.P., that is about one-half of the *total* power used in America for all its electric light and power stations, and it is only quite recently that a beginning has been made to utilise these vast stores of latent energy for driving gas engines and producing electricity.

Copper Refining.—Electrolytic copper refining is now a well-established industry, with a remarkable past, but a future more humdrum than romantic, and progress is therefore bound to be of the dry-as-dust statistical order. Moreover, copper refiners, especially in England, keep their secrets, if they have any to keep, very tight, so the labours of the recorder are light indeed. The most annoying thing about electrolytic copper in 1905 from the consumer's—the electrical engineer's—point of view was its price. Beginning at £70 10s. 7d. in January, it fell to £69 7s. 6d. in May, and then rose continuously to £85 12s. in December, the average for the year being £73 11s. The output, of course, is always increasing. The Lake Superior Mines yielded the record figure of over 200,000,000 lb. of ore last year. The American Smelting and Refining Co. and the De Lamar Co. are both enlarging their refining plants, the former to a capacity of 60,000 tons per annum. The Raritan Co. will alone shortly be turning out about 130,000 tons a year. The Balbach Co. is also enlarging its plant, and the Nichols Chemical Co.'s plant is now stated to be producing over 90,000 tons a year.

The various "fancy" methods—those of Elmore, Cowper-Coles, Harrison, &c.—if we may so call them, for electro-depositing copper tubes seem to be making some headway, and such tubes are being extensively used, among other purposes, for steam pipes, calico-printers' rolls, radiator tubes for motor-cars, &c. An ingenious advance is Mr. Cowper-Coles's method of depositing wire on a rotating mandrel that has been scratched with a V-groove.

In the electric winning of copper no substantial progress has been reported. Bodländer and Idaszewski have been trying their hand at electrolysing fused Cu_2S, but there seems to be no immediate prospect of extracting copper in this way. A good deal has been published about methods of treating refinery slimes, but we fancy the methods patented are not the methods used.

Nickel.—Mention of nickel may appropriately follow that of copper—in the concrete they are more difficult to separate. No electrolytic separation process is at present being used, the combine known as the International Nickel Co. having abandoned the use of the Browne process. But now that the Canadian Copper Co. has a new electric transmission plant, the prospects in this direction are stated to be improving. The Orford Copper Co. has recently been making experiments in the direction of nickel refining, using the chloride solution.

Aluminium.—August 26th, 1905, was the tenth anniversary of the establishment of the works of the Pittsburg Reduction Co., at Niagara Falls, the first of the 12 industries that now live near and by means of the Falls. Aluminium was then, of course, almost a rare metal, but the foresight and courage of the pioneers have been amply justified by time. During 1905 in particular, the sales of aluminium in England, as well as elsewhere, have gone up by leaps and bounds, in spite of the fact that its price in December was as high as £160 a ton; it is estimated that in a couple of years the capacity of the world's aluminium plant will be at least doubled. The total weight of aluminium produced in 1904 was some 8,000 tons, the output for last year was probably nearer 12,000. The British Aluminium Co., which controls the markets in this country, is now busy extending its plant, and in a year or so will have available 30,000 H.P. for the manufacture of the metal. The Loch Leven scheme is making visible headway; the contracts for dam, culverts, and pipes have already been let to Sir John Jackson, while specifications for the electrical plant, for which Prof. Kennedy is taking the responsibility, are understood to be well under way. This company's profits, which increased from £34,143 in 1903, to £55,400 in 1904, may be taken as an indication of the prosperity and future of the industry.

As regards the uses of aluminium, it is coming more and more into favour for electrical conductors, and the present high price of copper, of course, is a great help to it in its uphill fight against the older metal. Motor-cars and omnibuses now consume a large quantity, and much is used by steel makers, especially in the States. Although only 2 to 5 oz. a ton are put into open-hearth steel, and 6 to 8 oz. into Bessemer, if every ton of steel produced in America used it in these proportions, 5,000,000 lb. would be consumed annually in that way alone. The mixtures known as "Thermit," and Vautin's improved "Weldite," which contains aluminium silicide, are now responsible for a good deal of the consumption; the growing use of "Thermit" suggests the possibility of a specially cheap—because impure—variety of aluminium being manufactured to meet this demand. The most troublesome feature of aluminium manufacture is really the preliminary purification of the bauxite, and during the past year the ingenuity of inventors has been much exercised in the direction of simplifying or doing away with these preliminaries. Thus Hall has suggested purifying bauxite electrolytically, and Betts has recently proposed to reduce the ore directly to the metallic state in the form of an alloy of copper, iron and zinc, and then to refine electrolytically in a cell in which the impure anode would lie at the bottom, and the pure aluminium be deposited out at the top of the molten electrolyte. The future of aluminium may very largely depend on the success of these or similar processes.

(*To be continued.*)

THE "ROMAPAC" SYSTEM OF PERMANENT-WAY CONSTRUCTION.

Of all the many constructive problems which the tramway engineer has been called on to solve, and to all appearance had successfully solved, none is proving more elusive than that of modern permanent-way construction.

The facts that an electric tramway service involves heavier cars, running at more frequent intervals, at higher speeds and with greater braking effects, than was the case when the steam and horse car sufficed for the needs of a travelling public, and that these features inevitably lead to increased wear and tear of the track, accompanied by the need for more frequent renewal, have, in the majority of cases, only recently been brought home to the authorities concerned.

It is, in fact, one thing successfully to construct, and quite another successfully to operate, a tramway track.

Within the past year or two many efforts have been directed towards improving track construction—remedying initial structural defects, by the provision of anchors, heavier rail sections, more elastic foundations, &c., but so far as we are aware only one proposal, viz., that of the Romapac Co., aims at simplifying, and what is of more moment, cheapening, the inevitable track renewal, when it comes.

Briefly, the Romapac Co. propose to substitute for the ordinary type of tram rail a compound rail of special design and somewhat greater weight, in which the lower section forms part of the permanent construction, while the upper section can be easily replaced as occasion arises.

This, of course, enormously simplifies the work of renewal, as only the top stratum of each rail and the adjoining sets would be interfered with.

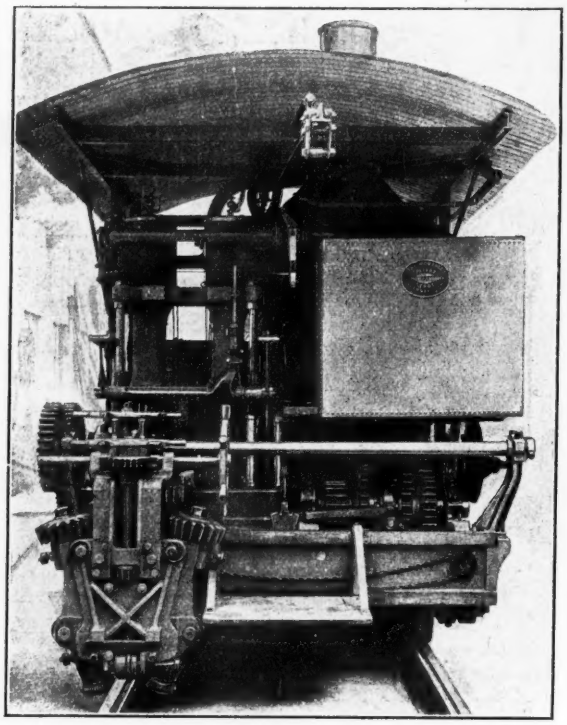
The idea of using a compound rail is not new, although up to now it has achieved no satisfactory application, chiefly on account of constructive difficulties; the Romapac Co., however, get over the latter by the use of specially-designed (patent) machines, which *(a)* roll and cold-weld the upper rail section to the lower one in the case of new construction or renewals, and *(b)* cut the worn upper section from the lower one, prior to operation (*a*), in the case of renewals.

On Friday last, through the courtesy of the promoters, we were able to witness the above operations at the company's depôt in Leeds.

It is interesting to note that the invention is not in the rails, but in the machines requisite for combining the two sections effectually together and, subsequently, separating them.

The rolling-on machine consists primarily of a couple of corrugated rollers, which rotate on, and at the same time by means of a toggle action force inwards, the depending flanges of the upper rail section, so as to grip or clasp the head of the permanent or lower tee section.

The second or cutting-off machine is similar to the above except that one of the corrugated rollers is replaced by a



The Romapac Rolling-on Machine; showing the Steam-Driven Trolley.

cutting tool, which makes a V groove on one of the bent flanges of the upper section as a preliminary to the final ripping operation of the third or breaking-off machine.

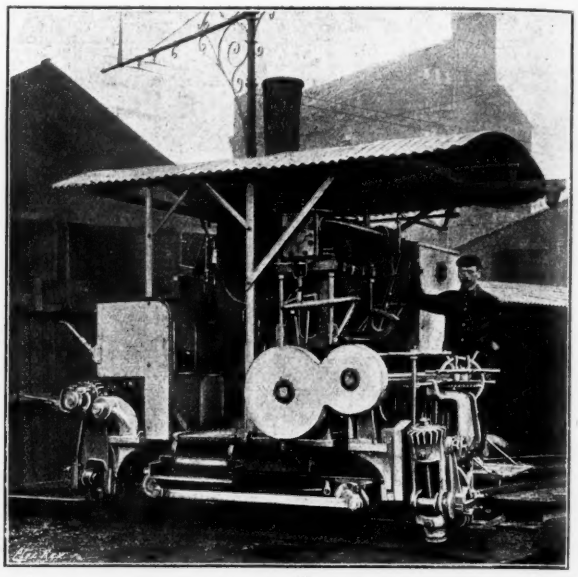
The latter machine is probably the most ingenious of the three devices; it rips off the partly severed flange and allows of the removal of the worn upper section.

The three machines on view were mounted on a travelling trolley, on which were fixed a boiler and engine to supply the necessary operating power; the arrangement will be clear from the accompanying illustrations. Obviously, the trolley wire would form a more convenient source of energy on electric tramways, and they only are concerned.

The various tests which have been carried out leave but little room to doubt the mechanical soundness of the combined sections; the bent flanges exercise a sort of spring grip on the permanent section, and some 23 tons pressure were required in a test made by the Sheffield Testing Works to slide the top section on the bottom one, in only one foot length.

Furthermore, the Romapac track, partly due to the increased weight of the combined rail section used, and also because of the ability to bridge the joints in the permanent sections by the upper ones, renders possible a more rigid track, and suggests freedom from rail joint troubles.

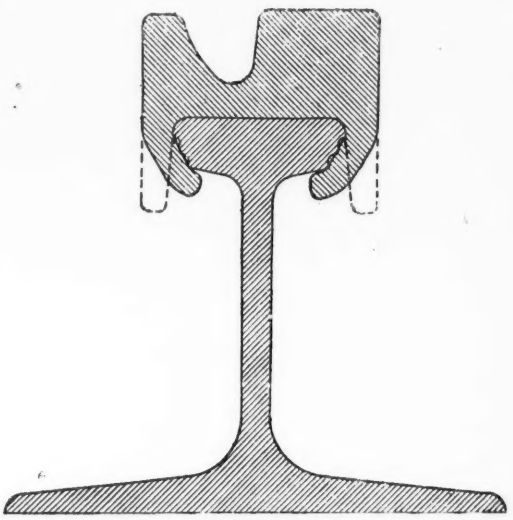
It may be mentioned that the company simply butt the



View showing the Arrangement of the Rolling-on and Breaking-off Machines, to right and left respectively.

ends of the adjoining upper sections together, the ends, however, being skewed.

Turning to the question of first cost, on which must hang, to a great extent, the success of any system, the heavier rail sections involve an increased expenditure, although not to the extent which might be anticipated, owing to the fact that the new sections cost less for rolling. The approximate cost of a mile of Romapac track is £1,488, which includes £1,213 for the rails and an estimated amount for bonding,



The Romapac Compound Rail; the outline of the Upper Section before Rolling on, being shown dotted.

jointing, rolling on, &c.; the rail sections weigh 45 lb. upper and 78 lb. lower, or 123 lb. per yard combined. By comparison, a mile of Leeds track with 105-lb. rails of ordinary type would cost £1,388, including £1,113 for rails, and £275 for bonding, welding, &c., or, on the values given, £100 less, an amount which, if actually trebled, should hardly deter a tramway authority from adopting the new system when the estimated saving in cost of renewals is considered.

This latter saving, according to Mr. J. B. Hamilton, the general manager of the Leeds City Tramways, may amount to as much as 53⅓ per cent., or in the case quoted £945 per mile, to which must be added an economy in the time taken

to effect renewal. Probably 8-10 minutes sufficed for the operation of rolling on, and a similar time was required for cutting off an average rail length, so that the continuous use of the two machines, one following the other, would render possible speedy renewals, a matter of importance in more ways than one on a busy route.

As far as one can judge of its merits, the Romapac system deserves a welcome at the hands of any tramway undertaking confronted with the uncongenial task of track renewal, and equally at the hands of the ratepayer in the case of municipal systems, for on his shoulders devolves the duty of paying the piper, whose bill is, even now, falling due in too many cases where depreciation and reserve funds are lacking.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Thermal Efficiencies.

Referring to the Horsfall Destructor Co.'s letter in your issue of 9th inst., we repeat that our experience is that steam-jet blowers average a working cost of about 15 per cent. for the same draught effect that a fan can give at a working cost of 1½ per cent. only.

If anyone could demonstrate that steam jet blowers can give a draught effect cheaper than a fan does, we would return to the former practice; meanwhile we hold that it is wasteful.

Cooling grate bars by steam is another matter altogether; no doubt 4 per cent. would serve that purpose, but Erith's stokers do not require any such cooling effect, for the simple reason that no grates are used.

We are quite ready to admit that wet air may improve defective combustion, and that it may also abate smoke nuisance. We also submit that watering the fuel may have a similar effect. But as efficient and smokeless combustion is unquestionably attained without wetting either the air or the fuel, we do not recommend these practices.

We invite any attempt to burn the clinker from Erith's grateless stokers; it will be found to be quite incombustible.

We have refused every suggestion that we should make what is called a "self-cleaning" stoker, precisely because we have often found that the refuse from moving-grate stokers contains as much as 25 per cent. combustible matter.

We agree that a destructor type of furnace will deal with such refuse fuel; but we submit that a better method is to use a mechanical stoker, which burns everything combustible in the fuel.

Erith's Engineering Co., Ltd.,
Charles Erith, *Director.*

London, *February 10th*, 1906.

I have read with considerable interest the correspondence on the above subject, which has been appearing in your columns for some time past.

In your recent leading article discussing this correspondence, you stated that there was need for a scientific examination of the various types of fuel calorimeters, and you suggested that it was quite possible that the difference between Mr. Bennis and Mr. Booth as to the possibility of attaining an 87 per cent. efficiency from steam boilers, might find an explanation in the type of calorimeter used for determining the actual calorific value of the fuel by Mr. Bennis in the particular test under discussion.

It may interest you and your readers to know that the comparative trials of the various types of calorimeters for which you ask, have already been carried out by two independent authorities, and the results obtained have been communicated to the Society of Chemical Industry in papers read before the London and Scottish Sections in the years 1903 and 1904. The authors, Messrs. Brane and Cowan, and Messrs. Gray and Robertson, support each other in the statement that the Bomb fuel calorimeter as originally designed by Mahler, or in one of its later modifications, is the only one that can be relied upon for giving correct results with all classes of fuel. Full details of these tests will be found in the *Journal* of the Society of Chemical Industry for November 30th, 1903, and July 15th, 1904.

As regards your explanation of the difference between Mr. Bennis and Mr. Booth, I think it highly probable that this is correct, for I myself have carried out many tests with the type of calorimeter which I understand Mr. Bennis is using for his fuel work, and except by conversion of the small sample into briquette form, I have never been able to obtain perfect combustion of the fuel. The results obtained by Mr. Bennis in laboratory tests of his coal would therefore most probably be lower than the actual calorific value, and this would cause the apparent boiler efficiency to be some 5 or 7½ per cent. higher than the real figure.

John B. C. Kershaw.

Waterloo, *February 12th*, 1906.

Electric Power in Graving Dock.

We have read with interest the letters of Mr. F. C. Parsons and "Glendale" in the current issue regarding temporary electric power installation in Govan Graving Dock, and it appears that the Fairfield Co. were the pioneers in this direction.

We would ask you, however, to refer to the original paragraph on page 103 of the issue of January 19th, in which it was stated that the installation applied to the *Omrah* some three weeks ago was the first of its kind in a public graving dock on the Clyde.

As the Fairfield Co. were actually taking the supply for the *Omrah* repair from the cables left by us from the *Victorian*, we naturally pointed out that the *Omrah* installation was not the first, and Mr. Parsons's letter puts this beyond doubt.

The main point of interest in connection with the *Victorian* installation was that in the adjoining dock a complete compressed-air plant had been fitted up, comprising boiler, engine, compressor, reservoir and pneumatic drills for hull repairs to the *Crown of Arragon*, and a good comparison was obtained of the rival powers.

The general opinion was greatly in favour of the electrical installation on account of its compactness, simplicity and economy as compared with the somewhat cumbrous and unwieldy pneumatic plant.

Archd. Watson & Co.

Glasgow, *February 12th*, 1906.

Overhead Equipment.

Notwithstanding Mr. Tweedy's first sentence, there is a wealth of rudeness in the three lines of his letter, and while I admire his discretion, I cannot admire his courage in leaving the brunt of an argument, originated by himself, to be borne by Mr. Dudgeon.

Until Mr. Dudgeon is prepared to accept actual facts, it is useless to offer him arguments based on these facts. I distinctly stated in my last article under what conditions the ears illustrating wear were obtained. When he is willing to admit that I can speak the truth, I shall be quite prepared to "explain the obvious," or to answer any of his arguments.

A Lineman.

Illuminating Engineering.

I notice that in your leading article on the above subject, on p. 202, no mention is made of the Linolite system of illumination, although it appears to me better to fulfil the conditions for diffused or hidden lighting recommended in that article than any other system of electric lighting I have seen. In the Linolite lamps the filaments instead of being coiled or bunched as in the ordinary bulb lamps, are stretched out in glass tubes, backed by polished reflectors, so as to form a continuous line of light. These lamps can be arranged on or near the cornice of a room, so as to reflect

their whole light on the ceiling, while the incandescent filaments are invisible, and they thus produce a beautifully diffused shadowless light, closely resembling daylight, which, according to carefully conducted tests by the Manchester School of Technolgy, throws a greater amount of light upon a given floor space for a given amount of electrical energy than do the ordinary electric lamps when used for direct illumination.

This light was installed in the ballroom of the Admiralty House, Portsmouth, at the time when the King of Italy visited this country, and I understand it was much appreciated by the guests, and I feel sure it is well worth the attention of electrical engineers.

C. T. Alfred Hanssen.

East Dulwich, *February 9th*, 1906.

London's Street Lighting.

I regret having made an error in my letter of the 6th inst. I meant City Square, Leeds, but put Victoria Square by mistake.

An Old Reader.

After-Dinner Speeches.

After searching the columns of your last issue in vain, I came to the conclusion that Mr. Hirst must resemble that courteous diplomatist, Mr. Arthur James Balfour, in one particular — he does not read the papers. Otherwise I am sure he would have made the *amende honorable*, which would be expected of every gentleman under the circumstances.

Goods Traffic.

A Suggestion for the Editors.

I respectfully submit to you the following suggestion as regards your "Correspondence" columns :—

That the discussion is conducted on exactly similar lines to ordinary society discussions—viz., the man who writes the first letter is allowed to answer all the criticisms on his original communication at the end of the discussion. That each writer is only allowed one letter. I think this would eliminate most of the personal element that undoubtedly creeps in. It would make every man do the best for his standpoint, and it would, therefore, raise the value of the columns as a useful portion of a useful paper, instead of being occasionally a cheap advertising medium. I should also like to add that a man can, with judicious clipping, generally limit his remarks to half a column.

D.

[As regards the ordinary method of conducting "society discussions," we have often expressed our opinion of its inefficiency. We quite agree, of course, that personalities should be avoided, and in very many cases we are strongly tempted to weed out a large percentage of irrelevant matter.—Eds. E.R.]

How to Screw Conduits.

I have read Mr. Schmahl's letter in your issue of the 9th inst. His letter appears to be mainly based on the preposterous suggestion, largely advertised by his company, that seamless steel conduit is made from scrap or rejected tube, and that the "Armorduct" quality of welded tube is the only perfect one. Such wholesale advertisements libelling competitors do not elicit much sympathy for the firm which issues them. For my own part, I do not desire to take advantage of a public discussion to advertise my company's products, but the plain statement that every seamless steel tube which we sell would satisfy the Admiralty or Board of Trade specifications for the highest class boiler tubes, disposes of three-quarters of Mr. Schmahl's arguments as far as my company is concerned.

As for the rest, Mr. Schmahl states that I "admit" that thin gauge tubes cannot be screwed. In a controversy like this to "admit" means to acknowledge that one has been convinced against a previous opinion. I have not "admitted" anything. I have plainly stated that the tube is useless and cannot be used, which is quite a different thing.

Mr. Schmahl attacks Mr. Waterhouse and talks of his sizes as being bastard, and the threads he characterises as being the same, but it seems to me that this kind of thing is only on a par with the advertisement I have referred to; a bastard size in one trade may be the standard in another. He also states that gas sizes and gas threads are the accepted standard for engineering work through the world. To this I give point blank denial. As far as the seamless steel tube trade is concerned, outside diameters and not inside diameters are invariably ordered, with the exception of a very slight percentage of steam pipes used for Government work.

Mr. Schmahl tells us what they do in America. Will he tell us in his next letter or advertisement whether or not his advocacy of the American system is adopted with a view to enable him to use American dumped tubes? I believe the Armorduct are not tube makers at all, or at all events, that they have not a factory in England. Why, then, does he presume to lecture us who do make tubes?

Mr. Schmahl asks why seamless tubes have not been more extensively used for gas, steam and water, and he suggests the libellous answer that scrap would likewise be used for their manufacture, and the engineering inspectors would not accept the tubes so made. The true answer, of course, is that hitherto weldless tube has been much dearer than welded, and the advantages of it for the purposes mentioned do not correspond to the increase in price. Now that the methods of production have been greatly improved, the price in many cases is approximately that of the welded tube, and the demand for seamless tube has increased enormously.

Mr. Schmahl constantly states in his letter that there is a large demand for gas sizes and gas threads for the conduit trade. In a somewhat extensive business the inquiries we receive for these sizes do not amount to probably $\frac{1}{4}$ per cent., certainly not to $\frac{1}{2}$ per cent., of our total output.

Mr. White's letter in your issue of February 9th seems to me the most important letter in your paper. Here is an example of a firm having tools, &c., for the old gas sizes, gauges and screwing, which abandons the use of them because the sizes condemned by Mr. Schmahl are the standard.

Not even articles four columns long, or the statement as to what they do or may do in America, or the inducement of being able to obtain foreign dumped tube at a cheap price, will induce my company to make any alteration in its standard.

The Perfecta Seamless Steel Tube and Conduit Co., Ltd.

A. E. Hills, *Director.*

Birmingham, *February 12th*, 1906.

Mr. Ernest White has by his letter, which is very much to the point, relieved me of the necessity of unduly encroaching on your valuable space for my reply to Mr. Schmahl's remarks. Mr. White informs us that the New Brotherton Tube Co., who are well known as manufacturers of gas, steam and water tubes, decided to add electric conduits to their business. They very naturally started to produce these conduits with gas sizes and threads, with a result unfortunate to themselves, as they found it impossible to get business. After making exhaustive inquiries among leading consultants and contractors, they find, as an explanation, an overwhelming volume of opinion in favour of conduit sizes and threads. Then, *very reluctantly*, Mr. White tells us, they put down a plant to meet the demand as they find it to exist.

The above statement of the case puts a very different complexion on the matter to that which Mr. Schmahl would have us believe. I may mention that the New Brotherton Tube Co., Ltd., are our largest competitors, and I hardly think "the loyalty of self-preservation" will hold water in view of the above remarks.

It may interest your correspondents to know that from the very inception of the Simplex Steel Conduit Co. we laid ourselves out to supply socket joint and screwed conduits, but the latter took rather longer to develop. Naturally we adopted the same standard of outside diameters for both, so that our large range of fittings could be supplied either bored or screwed, and Mr. Schmahl, while admitting and recog-

nising our standard for socket-joint material, objects to do so for screwed.

Mr. Hills pointed out that the thickness of gas tubes was originally settled for the convenience of welding, and every tube manufacturer knows that this is the case, and that it is not practicable to thoroughly weld a tube of lighter gauge than gas barrel. The high-welding temperature to which these tubes have to be brought unfits them in many ways, which it is hardly necessary to mention, for conduit wiring, and there is no rhyme or reason in increasing the gauge of brazed or solid-drawn tubes to make them conform to welded.

That a desperate effort is being made by certain firms to alter the present conduit standard gauges, and to substitute for them gas standards, is very evident. Mr. Schmahl would have us believe that he personally is disinterested and has no axe to grind, his sole object being to benefit the trade generally. I am of opinion, however, that there is more in his solicitude than meets the eye. "Armorduct," which is a prepared welded tube, was more or less dumped into this country by the American firm who were responsible for its manufacture, but for some reason or other the American supplies were discontinued last year. I had this from an official of the American firm, who offered to negotiate with me for the purchase of his stock in this country at a specially reduced price, but I was not a purchaser. I now understand Mr. Schmahl is obtaining his supplies of "Armorduct" (?) from a gas-tube manufacturer in this country, and these tubes are supplied with gas threads; hence his "direct and specific demand." The Armorduct Co., in their catalogue for 1905, described their thread as follows:—"The screw thread employed on armorduct conduits is a special electrical thread, which ensures easy and rapid fitting with good electrical conducting and water-tight joints." So long as Mr. Schmahl was supplying this tube, he showed no concern as to standardisation.

I may, therefore, be permitted to form my own ideas as to his disinterested motives in wishing to put conduit manufacturers into line with gas standards.

In view of the above, I do not feel in any way called upon to respond to the invitation to "face the ordeal"; not because I in any way contemplate an adverse verdict, but because it is unnecessary and could lead to no satisfactory result. If there is pressing need to standardise screwed conduits, which I am far from admitting to be the case, the matter must be decided by those having a thorough knowledge of the question from all points of view, and on broader lines than those of personal advantage.

L. M. Waterhouse, A.M.Inst.C.E.
The Simplex Steel Conduit Co., Ltd.,
Director and General Manager.

London, *February 12th*, 1906.

Electric Lifts.

My letter in your issue of the 2nd inst., directed only to one specific point—the possibility of higher mechanical efficiency in the gearing, and specifically disclaiming the institution of any comparison between different makes—has raised a veritable tornado in the breasts of Messrs. A. Smith and Stevens, who were not even mentioned—indeed, probably, on that very account.

They say I have made a "momentous discovery"; I say I have not. I distinctly gave the "Sprague people" the credit of being there already. They say: "Your correspondent, by one agile intellectual effort, leaps straight to the conclusion, &c." He did nothing of the kind, but indicated quite clearly that no exception could be taken to decently-designed worm-gear; witness the Sprague quick-pitch tandem gears.

The broad proposition was merely that mechanical inefficiency is not the best way to secure safety; that I still maintain as an absolutely unassailable statement of fact. Nevertheless, it may be, and probably is, equally true to say that Messrs. A. Smith & Stevens' lift-controlling gear will infallibly result in coroners' inquests, to use their own words, unless combined with inefficient winding gear. That proposition I cannot refute, for my friends admit—nay, claim—their brake to be "a notoriously unreliable and variable adjunct."

Alas, our agreement is of short duration. "For," they say, "be it remembered that with a high efficiency gear, control depends absolutely on the brake"—with an improperly designed arrangement, perhaps; with a well-designed combination of controlling gear and motor, certainly not; the control depends first on motor field strength to slow down, then on return of current to the line, and finally for accurate *stopping* on a "decently" designed electro-magnetic release brake which is neither unreliable nor variable.

I cannot follow Messrs. Smith & Stevens into their difficulties with the non-stop song of the soloist, but I suggest here, as in the treatment of lift problems, the application of gentler, more *rational* methods than the gag and the jerky brake.

Mr. Good's self-esteem will in no wise suffer if he only conceives that it is an "Unspeakable Scot" who did not know of his connection with Faraday House; he is the loser, not Mr. Good. I thank him for the light on "gray matter." Permit me to suggest a course of reading in American mechanical journals. He won't see the point just now, but he will in, say, 12 months!

But, ye gods and little fishes! what does he learn or teach or have to do (you see I have learnt my lesson, and am not presuming any more) at Faraday House to make him hold up holy hands and use naughty words at the idea of 70 per cent. combined efficiency for a motor and double reduction gear with shafts on roller bearings—*decently* designed gear, mind, not class-room wheels. I am not sure but that 93 per cent. might really be got with care, but I estimate the factors at—

$$\cdot 79 \times \cdot 95 \times \cdot 95 = 71 \cdot 5 \text{ per cent. (by slide rule).}$$

I need hardly press the point, but if Mr. Good will turn to p. 465 of the volume of *Minutes of Proceedings* Inst.C.E., issued last November, he will find a record of 90 per cent. efficiency for worm gear; reasoning by analogy he will not grudge me the additional 5 per cent. for spur gear.

I know perfectly well that the lifts he mentions will not budge without excessive current—that was the reason for my first letter, but I also know, as he does not, that the "increasing momentum" of a carefully designed high-efficiency lift reaches its limit quite close to that corresponding to the normal speed of operation.

W. L. Spence.

Glasgow, *February 13th*, 1906.

P.S.—I am reminded that the 70 per cent. efficiency quoted by me had risen to 71·2 per cent. after several months' operation, and that the lift had wood guides. If Mr. Good will read my letter carefully, he will see that I pointed out his failure to recognise the *combination* of a low-voltage motor of 8 H.P. with steel guides, as contributing to the efficiency of 41·4 per cent., he claimed it as due to steel guides merely.

Overhead v. Underground Lines in America.

My attention has been called to the discussion appearing in the editorial columns of your issue of December 15th, 1905, on my paper on "Overhead *v.* Underground Lines." Permit me to suggest that you have quite mistaken the scope and intent of the paper, and that your discussion was quite as "astonishing" to me as the paper seems to have been to you.

It was not the purpose of the paper to discuss the relative merits of the different systems of distribution, but rather the relative advantages and disadvantages of overhead and underground construction, as applied to the typical distributing system, commonly found in American cities of 15,000 to 25,000 inhabitants at the present time.

This typical system consists of overhead alternating current lines with transformers and poles in streets and alleys. In the business sections of such cities pole lines and transformers are usually located in the streets, and agitation is therefore prevalent among the municipal authorities looking toward the removal of the existing lines in the business portions of these cities and placing them underground.

It was the purpose of the paper, therefore, to discuss, first, the relative advantages and disadvantages of installation and

operation of overhead and underground lines; and, second, to determine whether it would be commercially feasible to replace existing overhead systems by underground construction in the average city of 15,000 to 25,000 inhabitants.

The underground system of ducts, or "culverts," illustrated in the paper, was therefore intended to represent the complete equipment which would be necessary for the business portion of the average American city of the size mentioned.

The general conclusion reached in the paper was that for such a business section the fixed charges resulting from the underground investment would add 1·2 cents per KW.-hour to the cost of current when the load factor is 12½ per cent., or in a residence section of the same area but having a maximum load of 20 KW. instead of 125, the added cost would be about 6 cents per KW.-hour under the same conditions.

The use of a sub-station and low-tension distribution therefrom was not considered, since the initial investment and operating expenses for such a system considerably exceed the amount required for the system described in the paper.

The location of transformers in sewer-drained manholes where it is impossible to hang them on poles has proven very satisfactory in America, in situations where the density and amount of load do not require units larger than 30 or 40 KW. For cities where the load is such as to require larger units, I certainly should favour "an all-underground system with sub-stations for the busy parts of the town, with overhead transmission to the outlying portions."

As to the use of the "built-in" system for the distributing mains by which you consider that the "risks of break-down would be enormously diminished," it is the experience in American practice that such is not the case, but rather the reverse is true. Indeed, in view of the ease in making changes, repairs or additions to the cable equipment and of the freedom from disturbance of street paving, it is the universal experience of American engineers that the "draw-in" system is the least expensive in the long run.

As to the "countless transformers, countless manholes, &c.," which, you fear, will cause the engineer-in-charge to sigh for "language that he cannot command," the writer is familiar with a number of working installations similar to that described in the paper, but several times greater in extent, in which more than two or three cases of trouble due to faults in the underground equipment during the course of a year would be considered excessive.

It is possible that the rate of depreciation used in figuring the increased cost of current with underground lines is a little high, but in view of the rapid growth of American cities, and the progress of the electrical art, which has heretofore necessitated discarding much of our physical equipment before it is actually worn out, it is wiser to err on the safe side.

I trust this explanation will make it plain that the scope of the paper was closely restricted, and that the method employed, if not "up-to-date" according to European standards, is strictly so under the conditions found in America.

H. B. Gear,
General Inspector, CHICAGO EDISON CO.

Chicago, *February 3rd*, 1906.

[We are pleased to publish Mr. Gear's reply, though we do not see that it materially alters the case. We were comparing American practice, as exemplified in the paper, with British methods of carrying out systems of distribution, and our main points were :—That the plan of drawing *distributing* cables into ducts is not only expensive, but useless and detrimental; that transformer boxes under the street surface have been abandoned here in new work for years past; that in this country overhead wires would not be permitted for a moment in a town containing upwards of 15,000 inhabitants, though, seemingly, this is all right in the United States. Doubtless it is due to the methods supported by Mr. Gear that the ratio of cost of underground to overhead distribution works out at such a high value, far in excess of what it ought to be, and while we approve of overhead conductors for small towns and villages, where electricity supply could not be carried out successfully with underground mains, we maintain that the latter are preferable, and can be installed on a sound and durable system, at half the cost arrived at by Mr. Gear. The general conclusion is that American methods of distribution are years in arrear of current practice on this side.—EDS. E.R.]

The Walthamstow Cables.

The following has been received, marked "Copy" :—

I have noticed your remarks "About some Cables at Walthamstow," which appeared in your last issue, and, while I do not intend to enter into a newspaper controversy either in the local or technical Press, I feel it incumbent on me to ask you, since you have given one version of the question as reported in one local paper, to be good enough to give equal prominence to the views of the other side, for which purpose I enclose the report of another local paper.

When it was found necessary to re-wire the Baths owing to the complete breakdown of the insulation on the wires, I asked for and obtained the permission of my Committee to use wire of which I had had experience and upon which I could thoroughly rely. By some error the fact of my so asking was omitted from the minutes at the time, though it is well in the recollection of those present, but as I am not responsible for the taking down of the minutes, the fault of omission is not mine.

I did not purchase the wire in question from "a local firm at an unnecessarily excessive figure" as you state, but from Messrs. Connolly Bros., Ltd., Manchester, at the usual trade prices obtaining at the time. My committee and the Council have more than once confirmed my action in this matter, and the question has only been reopened owing to the almost single action of one individual.

There is no mystery in the matter, and the abuse, certainly up to the time of the meeting which you report, has come exclusively from the one individual already referred to.

Relying on your spirit of fairness, although the contract was "only a little one,"

J. H. Fooks Bale.

[The newspaper account that our correspondent sends is very incomplete—it contains no reference whatever to the tussle that took place before the reading of the reports was agreed to. The report to which we alluded last week was apparently a report and nothing more; the one which Mr. Bale sends us gives no record of the discussion either before or after the reading of the charges and the engineer's reply, but it does undoubtedly contain editorial comments championing the engineer's cause. In the above letter—which Mr. Bale writes against his intention to enter into controversy—he ignores the existence of the contract with another cable manufacturer. We were under the impression that the transaction which has been described as irregular, was made with Messrs. Quicke & Co., a local firm. Does Mr. Bale suggest that the cables obtainable from the original firm at a lower price were not good enough for re-wiring his Baths? We still find some mystery surrounding the matter, and cannot agree with our correspondent in regard to the monopoly of abuse—especially after reading his own report.—EDS. E.R.]

LONDON UNITED TRAMWAYS AND THE EALING CORPORATION.

THE following letter was addressed to the Board of Trade by Sir J. Clifton Robinson, engineer to the London United Tramways, in reply to the report of the borough surveyor, on which we commented in our leader last week :—

The Assistant Secretary, *January 20th*, 1906.
Railway Department,
Board of Trade,
7, Whitehall Gardens, S.W.

LONDON UNITED TRAMWAYS—EALING CORPORATION.

Sir,—I beg to acknowledge receipt of your letter—R.611—18th inst., enclosing communication from the Corporation of Ealing, together with copy of report by the borough surveyor.

With respect to the surveyor's report, the following observations on the various matters to which he refers, in the order in which they are dealt with, may be in order:—

1. In conformity with the undertaking made to Col. Yorke, none of the 46 cars which were withdrawn from service have been again put into use until the approved alteration of the brake rigging has been completed. Sixteen of the number have been so dealt with, since which they have exhibited the same qualities of quiet running as were demonstrated in the case of the car put into operation during the Board of Trade inspection.

I take the strongest exception to the statement that the noise is now "as bad as ever," or that there have been any grounds for reasonable complaint since the date of the inspection. As a matter of fact, Mr. Jones's observations constitute the only complaint which has reached the company from any source since the improved arrangements were carried into effect.

2. The suggestion that the grinding of the rails which the company is carrying out at great expense is without beneficial result cannot be seriously regarded. Even a superficial inspection will demonstrate the improvement which is taking place in Ealing, in common with other places where similar operations are being conducted for the removal of corrugations on the rail tread.

3. The plans for the construction of the track in the Borough of Ealing were submitted to that Council in the usual way before the line was built, and the whole of the work was carried out under the personal supervision and to the unequivocal satisfaction of the borough surveyor, and is the same form of construction as is generally adopted even now by corporations and companies in building tramway lines.

In constructing our new line in Boston Road, as referred to in the surveyor's report, a system of heavy standardised rails, steel cross sleepers and anchor joints has recently been designed, which, I believe, will be found to be an improvement on the earlier methods. I observe the surveyor approves this design in connection with the new work, but, strangely enough, condemns it when applied, so far as practicable, to the renewal and maintenance work in connection with the tramways in the Borough of Ealing. The principal object of the improvement is to prevent any vertical movement of the rail under traffic, which is so detrimental to the road bed, and experience has shown that the anchors and anchor joints do effectually accomplish this purpose.

It is of course necessary to make small openings in the concrete for the insertion of these girder anchors, but the space is then filled in solidly with shingle and run in with pitch, the purpose of the latter being only to hold the shingle together and make a watertight joint. It is impossible for the surveyor to indicate a solitary place on any portion of the route which has been so dealt with where water is able to find its way under the concrete by passing these pitch joints between the girder anchors and concrete bed, and I regret the suggestion should be so unfairly made.

In our experience with this method of repairing (which now extends over more than 12 months) we find a decided advantage to rails and road-bed, otherwise we would scarcely continue to incur the heavy expense which is involved. As promised Col. Yorke, we are endeavouring to devise a scheme of thermit-welded joints which will, I hope, further strengthen the rails where most essential.

A reference to this matter appears in our leading columns to-day.

LEGAL.

The Manchester Tramways Goods Carriage Case.—Judgment.

A judgment of the utmost importance to all municipal corporations owning or carrying on tramways was delivered on 5th inst. by Mr. Justice Farwell in the Chancery Division of the High Court. Messrs. Sutton & Co., the well-known carriers, brought an action to restrain the Manchester Corporation from carrying on the business of common carriers beyond the radius of its tramway system. The facts of the case appear in his Lordship's judgment.

Mr. Justice Farwell said an injunction was claimed to restrain the defendants from acting as carriers or delivery agents except on their tramlines, and from spending the Corporation's money for that purpose and for incidental declarations. The defendants were incorporated by Royal Charter in 1839, and they justified the facts complained of both under the powers given to them under their private statute, and also under their common law rights and powers as a corporation by charter. They claimed the right to act as general or common carriers. The action was to a great extent *quia timet*, for the defendants commenced operations last year, and the writ was issued in May, 1905. The Corporation had called no evidence to show what business had actually been done by them, and their acts and intentions were gathered from the documents put in evidence, and by admissions and answers to interrogatories. Their intention was to put in operation a large and comprehensive scheme of parcels delivery and collection, and as part of that scheme they proposed to accept a tax on parcels *qua* parcels when the value thereof was not collected by them on delivery. They proposed the delivery of parcels by special messengers at special rates, and the insuring of parcels. They further proposed to act as agents for all railway companies, and to pay to the companies all moneys due to them for the carriage of parcels in consideration of 1d. per parcel for collecting. They also proposed to collect and deliver parcels outside the radius of their tramway lines, and goods which had never travelled, and were not intended to travel by their trams at all. In April, 1905, they issued a book of rates and arrangements for the conveyance of parcels traffic from Manchester to all parts of the United Kingdom and abroad, and described themselves as agents for all railway companies. They had spent several thousands of pounds in plant, vans and horses, and had engaged numerous agents and servants with a view to carrying on this business. All that expenditure had been, or was intended to be, entered in account upon what was part of the expenditure of the Corporation in respect of their tramway undertaking as part of the working and establishment expenses, and as part of the management of the tramways, &c. Now all the expenditure at present incurred in providing horses, trams, carts, offices and agencies used, and to be used, in connection with collecting, carrying and delivering parcels, had been defrayed out of the money borrowed by the tramway undertaking. The difference between a statutory corporation and a corporation created by Royal Charter was well settled. The former could do such acts as they were authorised directly or indirectly by statute creating it. The latter could, speaking generally, do everything that an ordinary individual could do. If, however, the Corporation by Charter were, as in the case of the defendants, a municipal corporation, then they were subject to the restrictions imposed by the Municipal Corporations Act, and would be restrained from applying their borough funds to purposes not authorised by that Act. If the defendants in this case had no statutory powers, it was plain they could not apply their borough fund either for the purposes of the tramway, or for the business of general delivery agents or common carriers. Granting that, theoretically, the Corporation by Charter could lawfully run tramways and carry on such business, they could not do it in practice without the expenditure of money, and it was accordingly argued in the present case that if, and so far as, the defendants were carrying on business as carriers in excess of their statutory powers, they were doing so under their common law powers, and could not be restrained. His Lordship proceeding, referred to the statutory powers of the defendant Corporation, and said a section of the provisional order of 1895 provided that the tramways might be used for the purpose of conveying passengers, animals, minerals and parcels. The Manchester Corporation Act, 1897, clearly contemplated the working of the tramways by the Corporation itself. It was common knowledge that by that time municipalities had in many cases been authorised to acquire works of a public nature within their boundaries with a view to working them for a profit. It was no part of the function of the Court to consider whether municipal trading of this or any other kind was or was not politic. His duty was to construe the Act by which the Legislature had conferred that power, and he knew of nothing that would authorise him to apply a principle of construction to an Act giving power to a municipality to carry on some trading operation differing from those applicable to their own Act. The Act of 1899, on which the defendants mainly relied, enabled the Corporation, in his Lordship's opinion, to run carriages and take tolls on all the network of tramways mentioned therein, and to use such tramways for the purpose of carrying, conveying and delivering animals, parcels, minerals, &c. Counsel for the plaintiffs had pressed upon him that there was no power to carry or deliver, but only to use the tramways for the purpose of carrying and delivering. This appeared to his Lordship to be too narrow a ground on which to found a decision. He referred to the Railway Clauses Consolidation Act, 1845, Sec. 86, and he found that there was no power to "carry and convey upon the railway all such passengers, goods," &c. He was unable to see any real distinction between this and the power given to the Corporation by Secs. 8 and 22 of the Act of 1899. But a railway company acting (as all railway companies now elected to act, and as the defendants acted) as carriers, and not as either toll-takers or conveyors, had undertaken the ordinary duties of a carrier. As Mr. Justice Byles put it in Taylor *v.* the Great Northern Railway, "the first duty of a common carrier is to carry the goods safely; the second is to deliver them." This duty to deliver would exist without the express use of the word in Sec. 22, and he could not read that section as restricting the Corporation to deliver from the trams. In the absence of motion or of special contract, he apprehended that a railway company was not bound to deliver at the house or shop of the consignee, but if they did not they were bound to keep the goods safely for a reasonable time, and to deliver to the consignee or his agent when he called for them. But there was nothing *ultra vires* in their delivery by cart or otherwise at the consignee's house, or to any other place authorised by him, including the station of a railway company, such goods as they had brought on their tramlines; such delivery was fairly incidental to their authorised business. It would be difficult in the present case to put any practical limit to the place of delivery. It could not be at the terminus only—this was probably in the highway—some radius of space within which a receiving store might be situated must be allowed, and some means of conveying to this store must be permitted. There was no ground for confining it to manual labour: indeed, the weights mentioned in the schedule of tolls negatived this. It must, therefore, be open to the defendants to use horses and carts, even to get the goods to their own depôt, and if they could do this he saw no reason why they should not be allowed to convey them to the consignee's address or to some other place named by him. So far, therefore, as the expenditure complained of arose out of the working of their tramway undertakings he could see no objection to it. The defendants were empowered to build goods stations for the reception and for the delivery of goods; to provide and pay for carts and horses and the like for collection and distribution, and to pay wages to men employed for those purposes, to provide buildings to house the horses and carts so used, to receive and transmit goods by rail, and to insure, for inasmuch as a common carrier

was an insurer of the goods entrusted to him at common law, it must be open to the defendants to make a bargain limiting such liability, or undertaking it on special terms. So far as regarded "cash on delivery goods," he had no evidence that this was part of the business of a common carrier, and he could only say that if it was, then the Corporation could accept goods for carriage and delivery on their trams on these terms, but that was all restricted to goods which travelled along the trams or some part thereof. There was nothing in the Act to authorise the Corporation to act as carriers generally without reference to their tramways. To collect and deliver parcels for the tramway was fairly incidental; to collect and deliver parcels outside the radius of the trams, and without any connection with the trams, was not incidental to the tram business, but distinct from it. At the best, it could only be said to be incidental to the incidental, and such reasoning would authorise a railway company to carry on a coal merchant's business because they must buy coal, and this was restrained in the Attorney-General *v.* the Great Northern Railway Co. For the same reasons he held that the Corporation could not act as general agents for the railway companies, but only in respect of tram-borne goods. The defendants, however, further contended, and he thought rightly, that the Corporation could so act by virtue of its corporate existence, and that this Court would only interfere to prevent the expenditure of the borough funds on such a venture. But they said also that there was nothing to show that they had made any such expenditure. He had, however, already stated that they threatened and intended to do so, and he was not satisfied that they had not already done so. It was obvious that a delivery service by carts to and from villages not connected with the company, and a general agency for all railway companies must entail expense, even if the same carts and men be used as were employed ordinarily in tram service proper; some of both were required, and there was wear and tear to be considered. He could not believe that a large, general delivery service and a general railway agency could be added to a service limited to the connection with trams without expense. No evidence had been given of the amount of such expenditure, but the plaintiffs, in his opinion, were entitled to an account at their own risk, of all sums so expended. He expressed no opinion as to the legality of the charges which the Corporation made for the services rendered by them in addition to the sums allowed by their Acts. The Attorney-General sued to restrain the improper use of the borough fund, and these charges, when received, were an increase to the borough fund. If anyone could complain, it was the person against whom they were made. The relative profited by them. If they were wrongfully made, and litigation ensued, it was not a matter of course that the costs, if the Corporation failed, would be allowed out of the borough fund; but however that might be, he was not aware of any authority which would justify him in preventing the Corporation from receiving payments simply because it might be doubtful whether they were properly recoverable or not. An individual could make such charges and receive them. If they were wrongfully made, he might be liable to an action. The Corporation, as a chartered Corporation, might do the same; there was no depletion of corporate funds by such receipts. Whether or not there would be when the payments were successfully reclaimed, he would leave to be dealt with when the question arose. No facts had been proved to show that the Manchester Southern Tramways Act, 1903, had any operation, and he could not read Sec. 87, Sub-Sec. 7, of that Act in the way proposed by the defendants. It could not have been intended to make tramways which the Corporation had neither purchased nor leased part of the undertaking of the Corporation. He proposed to make a declaration that the defendants were not entitled to expend any part of the city fund or the receipts of their tramway undertaking, or the proceeds of any city rate, or any other moneys of the defendants or of the city for the purpose of establishing, or maintaining, or carrying on the business of carriers except as part of and in connection with their tramway undertaking and in respect of articles carried along all or part of the tramways for the time being belonging or on lease to the Corporation, or on which they had power to place or run carriages, and to grant an injunction on similar terms. If the plaintiffs desired it, he would also direct an inquiry on similar lines, reserving the costs of such inquiry. He had felt some difficulty as to the costs of the action. The plaintiffs had failed on a part of their claim but they had also succeeded to a substantial degree. The action was properly brought, and the plaintiffs ought, he thought, to have the general costs but with some considerable deductions. He thought justice would be done by ordering the defendants to pay to the plaintiffs one half of their costs of the action, leaving the plaintiffs to bear the other half, and the defendants would, of course, bear their own costs. He would suspend the operation of the injunction for 14 days to enable the defendants to decide whether they would appeal or not.

Olympia Electrical Exhibition: Liability of the Promoters for Lost Electrical Cable.

In the Shoreditch County Court, on Thursday, before his Honour Judge Smyly, K.C., Fredk. Wm. Bridges and Geo. David Smith, promoters of the Electrical Exhibition at Olympia, of 119, Finsbury Pavement, E.C., sued Messrs. N. Burt & Co., of 195, Wardour Street, Oxford Street, W.C., to recover £6 14s. 2d., being the amount of electricity supplied by the plaintiffs to the defendants during the run of the Exhibition. The defendants counterclaimed £4 12s. 6d. for a cable which they alleged the plaintiffs had taken away wrongfully when removing the meter. Mr. Hands appeared on behalf of the plaintiffs. The defendants admitted the claim, and in support of their counterclaim, said that as the plaintiffs ran the Exhibition they were responsible for seeing that nothing was removed belonging to anyone else. After the Exhibition was over there was the usual rush to clear the things away, and Messrs. Burt contended that they cleared as soon as they possibly could, but before this the meter had been removed, and also the cable, which did not belong to the plaintiffs.

Judge Smyly: What really did the plaintiffs supply?

Mr. Hands: They supplied the current only. They let the floor space after arranging for the holding of the Exhibition.

Judge Smyly: And how is this price arrived at?

Defendant: We are charging for 444 ft. of cable, and it would not make any difference if it was new or old.

Judge Smyly: I hardly see why they took this cable if it did not belong to them.

Defendant: It certainly did not belong to them; we put it there ourselves.

Mr. Hands: But, your Honour, so far as we are concerned, we are not liable in any way. The Exhibition closed on a Saturday, and it was not until the following Thursday that the defendants applied for their pass into the building to clear away their goods, and by that time there had been hundreds of carmen in and out clearing away stuff. On the form of agreement which is signed between the parties, there is a clause which says that the plaintiffs will use every reasonable care to ensure that any exhibit, or anything appertaining to the Exhibition, will be looked after; but they do not hold themselves responsible for any burglary, fire, or illegal act.

Judge Smyly: But did they have this cable, or do they know where it has gone to?

Plaintiff: We know nothing about it at all. We cleared the meter away, but beyond that we know nothing. On the Thursday the loss of the cable was reported, but hundreds had been in the building before that.

Judge Smyly: And, therefore, if it was stolen by one of the carmen you consider you are shielded by the larceny clause in the agreement?

Plaintiff: Most certainly. We say, under any circumstances, we are not liable, and should not think of accepting any liability in the matter.

Judge Smyly: Can you prove that it was taken away by the plaintiffs?

Defendant: No; but it must have been, though.

Mr. Goodwin was called for the defendant, and said that he went to the Exhibition to clear away the goods and found the boards had been pulled down, which must have been done to get the cable.

Judge Smyly: But this agreement seems perfectly clear they are fully protected.

Defendant: But surely they are responsible in such a case as this. They promote the Exhibition, and afterwards have the building under their sole control, persons only being able to get in and out with a pass from one of them.

Plaintiff: Yes; and there might have been 1,000 carmen between the Saturday and the Thursday.

Defendant: Yes; but you are the only responsible ones that have access, and surely make yourselves responsible to see that goods are cleared away in a proper manner.

Plaintiff: We do not hold ourselves liable in any way; anything might have happened to this cable for aught we know.

Judge Smyly: It seems pretty clear anyway that the plaintiffs are protected, and therefore I shall give judgment for the plaintiffs on the claim, and the defendants, Messrs. Bridges and Smith, on the counterclaim; at least, I will make it a non-suit on the counterclaim, with costs.

Claim against City and South London Railway.

A man named Middleton sued the City and South London Railway Co. for damages for personal injuries sustained by him through being pushed forward on the Elephant & Castle Station platform on May 14th last, at 11 p.m., so that he fell, with a child on his arm, down a gap between the carriage and the platform. The jury awarded £8 10s., but Judge Lumley Smith, at the City Court, said that there would be no costs as the action had been remitted there from the High Court, and less than £10 was recovered. The railway company said that during its 16 years' running it had carried 160 millions of passengers and no passenger had ever before slipped between the platform and a carriage.

Priestley *v.* Marylebone B.C.

Before Mr. Justice Warrington, in the Chancery Division, on Friday, Mr. Cave, K.C., mentioned the case of Priestley *v.* the Marylebone Borough Council, which he said was a nuisance case.

Mr. R. J. Parker, for defendants, said he was afraid his Lordship could not make the order which the plaintiffs asked, as it would involve stopping the supply of light to a great portion of London.

Mr. Cave: But, in the meanwhile, the Council are throwing volumes of steam into our premises.

Mr. Parker said this was a new generating station at Marylebone, and though the works were not finished yet, a great quantity of light was being supplied. There were windows and doors to be put in, and that might make a great difference in what plaintiffs complained of. The works would be finished in two or three months.

Mr. Cave said that was too long, as plaintiffs were losing their tenants, and it was impossible to carry on their business.

It was arranged that the motion should stand over for a week.

BUSINESS NOTES.

Tramcar Lifeguards.—Messrs. Hudson & Bowring, Ltd., of Manchester, have received orders for the fitting of cars with their lifeguards from the London United Tramways; the London County Council; and a further order from the Swansea Tramways.

Luton Destructor.—On November 29th, 1905, the Horsfall Destructor Co., Ltd., received an order from the Luton Corporation to add another cell to the destructor already erected by them. A start was made on the new cell on December 13th, 1905, and the work proceeded with and completed by January 5th, 1906, without interfering in any way with the ordinary working of the two cells previously built. The extra cell, like the two others, has a capacity for burning 15 tons of refuse per day.

Brush Contract.—The County of Durham Electrical Power Distribution Co. (per British Electric Traction Co.. Ltd.) has placed a contract for eight 500-kw. three-phase transformers with the Brush Electrical Engineering Co., Ltd.

Annual Dinner.—The Annual Dinner of the E.C.C. Drawing Office Staff took place on February 10th at the Talbot Hotel, Wolverhampton. After dinner an enjoyable musical programme was gone through, under the chairmanship of Mr. S. Bourne.

Catalogues and Lists.—The Tudor Storage Battery Export Syndicate, 35, Surrey Street, Strand, W.C.—New illustrated export catalogue giving full information relating to their stationary storage batteries. It has been the aim of the compilers to include all data necessary to enable intending purchasers abroad to prepare precise estimates and other preliminary work connected with Tudor battery plants without first referring to the company. Detailed specifications of all parts connected with the batteries, also technical data concerning same, are given. Weights and measurements are all expressed in English and metric equivalents. There is also a useful list of code words. A convenient thumb index divides the several sections.

Sir W. A. Rose & Co., Upper Thames Street, E.C.—Circulars relating to "Harp Brand" electric lubricant for dynamos, motors, engines, &c.

Messrs. Isenthal & Co., Mortimer Street, W.—Fully illustrated catalogue (96 pp.) relating to the "Electra" system of electric heating and cooking. In Section 1 there are shown and priced a large variety of radiators of different types, cooking ranges and ovens, plate warmers, grills, electric jugs, kettles, and other appliances for domestic purposes and for use in hotels and clubs. Section 2 describes a number of technical appliances &c., for use in factories and laboratories, including large bakers' ovens, soldering bits, glue pots, ether stills, hot-plates, flat irons, cauldrons, and boilers, immersion heaters, &c.

Messrs. Ed. Bennis & Co., Ltd., Victoria Street, S.W.—Two pamphlets (1) describing the mechanical stoking and coal-handling machinery supplied by the firm for Coventry Electricity Works, and (2) illustrating and particularising such plant which has been erected by them at City Road and Bankside Electricity Stations in London. Copies of these may be obtained on application.

Messrs. Browett, Lindley & Co., Ltd., Patricroft.—New catalogue just issued giving full particulars of the "Browett-Lindley" forced lubrication steam engines for electric lighting and power transmission works. Sizes, speeds, powers and weights are stated clearly in tabulated form, also results of tests. Some excellent half-tone views and sectional drawings and a general specification appear, also a list of some of the more important power stations where such engines are installed.

The Chloride Electrical Storage, Co., Ltd., Clifton Junction, Manchester.—Handy pocket-shape catalogue (112 pp.) giving particulars of the improvements which have been effected in the Chloride accumulator, and detailing in tabulated form the data concerning the various types of battery, such as charge and discharge rates, capacity, weights and dimensions, prices, &c. Information also appears relating to acids and a number of accessories.

The Electrical Co., Ltd.—Several new lists dealing respectively with electric cigar lighters, brush-holders, electrically driven ring spinning three-phase motor driving through helical-cut gearing, and an electrically driven ring spinning frame, also a general view of an electrically driven ring spinning mill.

The Alliance Electrical Co., Ltd, London.—Circular briefly describing their third-rail haulage system for electrical work in collieries, and its "enviable loneliness."

The Horsfall Destructor Co., Ltd., Leeds.—New catalogue, giving particulars of some of the destructor plants that they have erected at Manchester, Leeds, Bradford, Batley, Grimsby, Accrington, and other places in this and other countries; also clinker crushers, mortar mills, &c. Photographic views are given of many of these installations.

Messrs. Newtons, Ltd., Taunton.—Set of illustrated sheets, filed in an expanding cover, giving particulars in general and tabulated form, also clear half-tone and diagrammatic views of the "Mawdsley" dynamos and motors as made by them under the licence of the "Zone" Patents Co.

Messrs. Monte Callow & Co., London, E.C.—Illustrated card giving prices of the "Emsea" watertight ironclad combined switch fuses.

Messrs. E. S. Hindley & Sons, 11, Queen Victoria Street, E.C.—Leaflet showing their enclosed high-speed engines of new design.

Messrs. Ferranti, Ltd., Hollinwood.—Two catalogues: No. 66, describing and illustrating their tubular non-arcing enclosed fuses; and No. 69 relating to double-pole and single-pole voltmeter switches.

Messrs. Mavor & Coulson, Ltd., Glasgow.—The firm's calendar card for February illustrates an example of a 3 ft. 6 in. hitch, through which a medium size Pick-Quick machine works, undercutting 4 ft. deep.

The Electrical Power Storage Co., Ltd., London, E.C.—New circular giving particulars, prices and illustrations of their miners' electric safety lamps, fitted with "Osmi" filaments.

Messrs. Elliott Bros., Lewisham.—New illustrated price list relating to their type S.C. ammeters and voltmeters for laboratory use.

The Electric and Ordnance Accessories Co., Ltd., Birmingham.—Catalogue (C 118) particularising in great detail and with the aid of half-tone illustrations and line diagrams of connections and dimensions, the "Stellite" controllers for electrically-driven cranes, machine tools, &c. A good deal of data is given in tabulated form, and prices are set out.

Messrs. Wm. McGeoch & Co., Ltd., Glasgow, &c.—Illustrated circular of the "Warwick" electric radiators.

The Hart Manufacturing Co., Ltd, 25, Victoria Street, S.W.—New illustrated catalogue, with prices, of the Hart "Diamond H." switches.

Messrs. Baughan & Co., London Street, Reading.—Circular giving prices and particulars of the "Beacon" flame arc lamps.

Alleged Fraud.—At the Lord Mayor's Court on 5th inst. an old, well-dressed man, named Henry Townsend (aliases A. Forrest and S. Vaughan), described as an electrical engineer, was committed for trial on a charge of unlawfully obtaining £1 from Mr. Herbert Page by false pretences, with intent to defraud. Mr. R. Tweedie Smith prosecuted, and said that Townsend had made a practice of calling on various electric contracting firms in London and the suburbs, and pretending that he was a gentleman of means, he would request the firm upon whom he was calling to undertake the fitting up of the electric light at his country house, usually about 50 miles from London, and the supposed residence would be about five miles from the station. On November 4th he called on the prosecutor, an electrical engineer, at 63, Queen Victoria Street, and told him that he wanted him to put in an electric light installation at his country residence, Park Hall Farm, Ivanhoe, Tring. He made an appointment for the prosecutor to go down there, and as he was leaving he mentioned that he had been detained rather longer in town than he had anticipated, and was short of money. Prosecutor offered to lend him £1 for his fare home, and this the prisoner took, giving an I.O.U. for it. It was subsequently found that there was no such place as the prisoner had mentioned, and that the representations he had made were false.

For Sale.—On February 22nd Messrs. Percy Huddleston & Co. will offer a quantity of electrical apparatus for sale at Manchester.

At Willesden, on February 28th, Messrs. Fuller, Horsey, Sons and Cassell will sell by auction various new india-rubber plant and machinery, of which some particulars appear in our advertisement pages to-day.

Book Notices.—"Heat and Steam (Elementary)." By Engineer-Commander A. E. Tompkins. Being an introductory supplement to a Text-Book of Marine Engineering. Portsmouth: J. Griffin & Co. 1s. 6d. net.

"Proceedings of the American I.E.E." Vol. XXV. No. 1. January, 1906. New York: The Institute.

"Notes on Metals and their Ferro-Alloys Used in the Manufacture of Alloy Steels." By O. J. Steinhart. Excerpt from the *Transactions* of the Institution of Mining and Metallurgy. London: The Institution.

"Report of the University of Leeds, 1904-5." Leeds: The University.

"A Technological and Scientific Dictionary." Part XII. Edited by G. F. Goodchild and C. F. Tweney. London: Geo. Newnes, Ltd. 1s. net.

"Atti della Associazione Elettrotecnica Italiana." Vol. IX. November, 1905. Rome: Sede Centrali, 397, Corso Umberto I.

"Continuous-Current Armatures: Their Winding and Construction," and "Alternating-Current Windings: Their Theory and Construction." By C. Kinzbrunner. London and New York: Harper & Bros. 3s. 6d. net each.

"Constructions of Electric Machines and Apparatus." By C. Kinzbrunner. Part I. Switchboard apparatus—A series of 10 plates. London and New York: Harper & Bros. 2s. 6d. net.

"Le Tunnel et Le Chemin de Fer Electrique de la Jungfrau." By G. de Fooz. Brussels: Société Belge de Librairie.

"Brass and Iron Founding." By J. E. Dangerfield. London: Dawbarn & Ward. 6d. net.

"Engineering Tables and Data." By W. W. F. Pullen. Second Edition. Manchester: The Scientific Publishing Co. 2s. 6d. net.

"Practical Pattern Making." By H. Aughtie. Second edition. Manchester: The Scientific Publishing Co. 4s. net.

"Report of the Committee of the North of England Institute of Mining and Mechanical Engineers upon Mechanical Coal Cutting." Newcastle-on-Tyne: The Institute. 10s.

An important work upon Steam Turbines, by Messrs. T. Stevens and H. M. Hobart, giving the most recent results in practice, and having a succinct account of the latest types, will be issued by Messrs. Whittaker & Co. in March. It will contain exhaustive comparisons between steam turbine and piston engine economies, and from the results rational conclusions are formulated as to the respective cases in which these two types of prime movers should be employed. More complete details than have been published before of many of the most recent steam turbine generating stations on

both sides of the Atlantic are included. The work will extend to some 600 pages, and will be well illustrated.

Prices Reduced.—Messrs. Elliott Bros. are announcing reductions in the prices stated in their recently issued catalogue of continuous current voltmeters and ampere-meters.

Dissolutions and Liquidations.—Patent Regenerative Furnace Co., Ltd.—A petition for winding-up this company presented by T. C. Williams & Sons, Ltd. (in liquidation) and B. P. Allnatt, is to be heard in London on February 27th.

Messrs. W. Gee & J. W. Ditchfield, electrical and mechanical engineers, Weymouth, have dissolved partnership. Mr. Gee will attend to debts and continue the business.

Electrical Treatment Association, Ltd.—A meeting is to be held at 66, South John Street, Liverpool, on March 13th, to hear an account of the winding-up from the liquidator (Mr. H. A. Maw).

Mexican Electric Works, Ltd.—Creditors must send particulars of their debts, &c., to Mr. Arnold Ellert, the liquidator, at 65, Old Broad Street, E.C.

Trade Announcements.—Mr. Theodore Schontheil, who has been for the past five years Messrs. Robert W. Blackwell and Co.'s engineer and representative in South Wales and the West of England, will, from 1st inst., act as their agent in the same district. Mr. Schontheil has entered into partnership with Mr. S. B. Haslam as Haslam & Schontheil, with offices at Western Mail Chambers, Cardiff. They will take up the sale of electrical and mechanical plant of all kinds.

The Crane Co. announce that they have decided to discontinue their London office (95, Queen Victoria Street, E.C.) at the end of January, after which date all correspondence should be addressed to Crane Co., 490, Cherry Street, New York.

The Societa Italiana di Elettricita Siemens-Schuckert, of Milan, inform us that from the 20th ult. their Turin offices have been transferred to Corso Siccardi, Angolo Via Ottavio Revel, N. 20, Turin.

New Paper.—We have received a copy of the first number of *Progress: Civil, Social, Industrial*, which is a shilling quarterly publication and is the organ of the British Institute of Social Service. It contains a number of interesting articles dealing with different aspects of social amelioration, its object being to keep readers acquainted with what is being done in different parts of the civilised world for the improvement of the conditions of life, and especially in regard to civic, social and industrial betterment. The publishing offices are at 11, Southampton Row, W.C.

Bankruptcy Proceedings.—Alfred Sutton.—Under the failure of Alfred Sutton, dealer in electrical fittings, &c., 329, Kennington Road, 17 and 18, York Terrace, Clapham, and late of the Fairy Archipelago, Crystal Palace, the debtor attended last week before Mr. Registrar Linklater at the London Bankruptcy Court for public examination. The statement of affairs shows total liabilities £937 14s. 9d. (unsecured £775 14s. 9d.) and net assets £162. Questioned by Mr. E. S. Grey, Official Receiver, the debtor said he had also dealt in cutlery, hardware, optical goods, tobacco, fruit and confectionery. His father died in 1891, leaving ten children, each of whom was entitled to a share of the estate. Witness took over the business, and promised to pay £20 to each brother and sister, but he had only been able to settle with four of the number, and only just made a living out of it. A shop was taken in July, 1903, at York Terrace, Clapham, for the sale of electrical fittings, the trading style there being "Sutton's." It was not a financial success. In the course of last year witness had to go to money-lenders. Falling into arrear with the payments in December, he was served with a writ, and, acting upon legal advice, he filed his petition. The examination was concluded.

Jas. Wood Smith.—At Blackburn Bankruptcy Court on February 8th, Jas. Wood Smith, trading as Smith & Co., electrical engineers, of 55, Bolton Road, Darwen, appeared for his adjourned examination. No details beyond those which have appeared in the Electrical Review transpired, and the examination was closed.

Messrs. A. Holmes & A. McCallum (Holmes & McCallum, electrical engineers, Victoria Street, Darwen).—February 24th is the last day for the trustee, Mr. T. Hindle, District Chambers, Darwen, to receive proofs for dividend.

Peter Pilkington, Ltd., Bamber Bridge.—February 24th is the last day for proofs of intended dividend to be received by the trustee, Mr. J. Todd, 3, Winckley Square, Preston.

The McGuire Manufacturing Co., Ltd., Westminster.—February 26th is the last day for sending in proofs to the liquidator, Mr. F. W. Pixley, 58, Coleman Street, E.C.

Albert John Harris, electrical engineer, Borough Mills, Bradford.—At the Bradford Bankruptcy Court on Tuesday, an application was made for the discharge from bankruptcy of Albert John Harris, electrical engineer, of Borough Mills, Bradford. The application was made by Mr. W. Durrance, who applied for an immediate discharge on the ground that the assets greatly exceeded the liabilities, as the debtor had claimed would be the case at the time of the making of the receiving order. No opposition was offered, and the immediate discharge was granted.

LIGHTING AND POWER NOTES.

Bargord.—The local Chamber of Trade has decided to support the proposal of the U.D.C. to obtain energy in bulk for distribution for lighting purposes.

Beckenham.—The U.D.C. has declined to adopt a recommendation from the E.L. and Tramway Committee, that the Council should apply for powers to enable it to supply energy to West Wickham.

Belfast.—A correspondent has written us as follows, on the lighting of the city:—"The electric tram system was inaugurated in Belfast some three months ago. Poles in the centre of the street are generally used, and as these are practically invisible after sun-down, oil lamps are attached to each pole. Street lighting is by means of gas—incandescent and flat flame. Royal Avenue at night is probably without a parallel in Europe—incandescent gas down the side—twinkling oil lamps down the centre; and this in one of the broadest thoroughfares Britain (U.K.) can boast of. Truly, a notable example of municipal enterprise, and a triumph for gas." Our correspondent's letter is a timely one; such triumphs are much appreciated by the gas journals, although not by the groping wayfarer.

Birkenhead.—The Electricity Committee has recommended the T.C. to apply for a loan of £11,896 for electricity purposes. The sum is made up as follows:—Two water-tube boilers, £2,570; 350-kw. steam dynamo, £3,040; condensing plant, £3,500; booster balancer, £635; pipe work, £825; crane, £184; removal and re-erection of three existing dynamos, £350; contingencies, &c., £642.

Buckingham.—The T.C. has adopted the recommendation of the Lighting Committee to accept the tender of the E.L. and Power Co. for public lighting. Hitherto gas has been used.

Continental Notes. — France. — According to *L'Industrie Electrique*, the Municipal Council of Paris has announced that it will receive, up to March 1st, 1906, proposals for the future organisation of the supply of electricity to that city. These proposals must either provide for an arrangement including a transitional stage lasting several years, whether utilising, or not utilising, the equipment of the existing companies, or must embody a scheme altogether independent of an intermediate *régime*.

Italy.—A concession has been applied for to erect a hydro-electric plant on the River Valle di Zerbo, at Abbadia (Como), for E.L. and power purposes.

Roumania.—The Pitesci municipality has decided to invite tenders for the electric lighting of the town.

The municipal authorities of Konstanza have decided to install an electric lighting and tramway system.

Switzerland.—The Municipality of Schaffhausen will shortly invite tenders for the improvement of the town electric generating station, and the erection of high-pressure turbines, at a cost of about £45,600.

The Municipality of Bellinzona (Ticino) has decided upon the erection of an electric power plant on the Morobbia torrent near Guibasco. Its present small alternating-current station is insufficient to meet the present demand.

Sweden.—The municipal authorities of Kristinehamn have received an offer from Mr. W. Olsen, of Stockholm, to supply electrical energy generated from the Munk Falls at Svarta, at the rate of 70 krone per H.P.-year, or 1,000 H.P. for a sum of 70,000 krone (£3,850) per annum. As a pendant to this offer, the Skandinaviska Elektricitetsverk, Stockholm, has intimated its readiness to cede to the municipality its lighting station at Kristinehamn, with machinery and inside and outside equipment, for a lump sum of 250,000 krone (£9,750).

Dundee.—The T.C. has had before it a report by its electrical engineer (Mr. H. Richardson) recommending the establishing of a new station at a total estimated cost of £70,000. Mr. Peter Fisher, the manager of the tramways, suggested that the tramways department should lay down generating plant to meet tramway requirements. He was advised that a station to meet all tramway requirements would only cost £17,000. Mr. Richardson, however, disagreed with the latter estimate.

Ealing.—On the 9th inst. a L.G.B. inquiry was held into an application by the T.C. for sanction to borrow £25,000 for E.L. purposes, made up as follows:—£5,000 for new machinery, £278 for transformer sub-stations, £19,184 for mains and services, and £537 to cover cost of services already provided. There was some opposition.

East Molesey.—The Twickenham and Teddington Electric Supply Co. is prepared to enter into an agreement with the U.D.C. not to erect generating or distributing stations upon any site within the district which has not been previously approved of by the Council, such approval not to be unreasonably withheld.

Felixstowe.—The U.D.C. has taken counsel's opinion as to the claim of the Suffolk Electricity Supply Co. to the payment of £3,000 to them by the Council, and the result is that the Council is advised to pay the sum named.

Frimley.—Mr. H. B. Renwick, secretary to the Camberley Electric Supply Co., attended a meeting of the U.D.C. on the 6th inst., when a resolution was passed consenting to the application of the company for a prov. order, subject to details being settled.

Frome.—With reference to the new prov. order for E.L., which a recent decision in the courts has made it necessary for the Council to apply for, the U.D.C. has received objections from the Gas Co. and a private firm of ironfounders.

Gravesend.—Messrs. Hooper, Leavy & Co. and Mr. Sidney Blandford have offered to take up the wiring of houses on terms of deferred payments, or rental in lieu of payment, on condition that the Corporation gives them certain support, and that such support be not extended to anyone else. The T.C. has authorised the Electricity Committee to enter into the proposed arrangement. It is explained that Messrs. Hooper, Leavy & Co. and Mr. Blandford were prepared to come into the town and spend £5,000 in three years. Consumers would not be absolutely bound to employ either of the two firms, but the Committee would refer applicants to these firms, and in collecting the accounts would receive those for wiring at the same time. The arrangement is to last for 17 years.

Grays.—The U.D.C. on February 8th decided to discontinue the maximum demand system, and to supply on a flat rate at the following prices:—Up to 100 units per quarter, 5d. per unit; over 100 and up to 250, 4¾d.; 250 and up to 500, 4½d.; 500, 4d. Meter rents were revised as follows:—Five-ampere, 1s. per quarter; 10-ampere, 1s. 6d.; 25-ampere, 2s.

Greenock.—The deputation appointed by the T.C. to inspect destructor installations has prepared an elaborate report on visits paid to Glasgow, Ayr, Fulham, Hackney, Liverpool, Mansfield, Nottingham and Partick. The report states that the utilisation of refuse destructors for the generation of electrical energy has made remarkable strides within the last few years, and that there is in operation no fewer than 74 municipally-owned destructor installations working in combination with electric supply stations. The deputation, we gather from the report, is highly in favour of working a destructor in combination with the electrical undertaking, and the advantages of so disposing of its town's refuse are set out. On the question of capital cost, the deputation estimates it at £15,000 to £16,000. The deputation continues, assuming that such a system was adopted in Greenock, and that the capital cost of the destructor amounted to £16,000, borrowed at 3½ per cent., the cost to the cleansing department for destroying the refuse (estimated at 16,500 tons) would work out at £920 per annum, or about 1s. 1d. per ton. Further, that if the wages and repairs on the destructor amounted to 1s. 6d. per ton, and that 40 units were generated per ton of refuse destroyed, the result would be that the electricity department would obtain steam to generate 660,000 units of electricity at a cost of £1,238, or 0·45d. per unit.

Halesowen.—The B. of T. has informed the U.D.C. that it intends to revoke the E.L. order. The board has been asked to reconsider this decision, but has refused to do so.

Hartlepool.—It was announced at a meeting of the T.C. on February 7th, that the Northern Counties' Electric Supply Co. had agreed to reduce the charge for energy for all street lamps, over and above those originally installed, from 3d. to 2½d. per unit, and to lower the charge to general consumers from 4½d. to 4d. per unit.

Hebden Bridge.—The U.D.C. has applied to the L.G.B. for a loan of £2,570 for E.L. purposes.

Hipperholme.—As a result of the circulars recently issued by the U.D.C. on the E.L. scheme, the ratepayers have decided against the proposal to introduce electricity.

Ilkley.—The U.D.C. has resolved to ask the B. of T. not to cancel the E.L. order, as it is the intention of the Council to put it into force as soon as there is a sufficient demand for energy to justify the outlay.

India.—Calcutta.—We understand that the Indian Government contemplates driving the Mint electrically. Various alternative schemes have been put forward, and will be adjudicated upon by the authorities in Calcutta.

Kashmir.—Acting under the advice of Major A. J. de Lotbiniere, the Kashmir Government is seeking to attract power users to that feudatory State. The allurements leave Niagara far behind. For the first year an inclusive price of £8 per H.P. per annum is to be charged, quite independent of the number of hours that the plant may be working. For succeeding years the charge is to be ½d. per H.P. per hour, with a minimum charge of £8 per H.P. installed per annum. In the case of interruptions in the supply attributable to the generating plant or transmission, a rebate for each hour of interruption is to be allowed. Water-power from the Jhelum River is to be used.

Ivybridge.—The U.D.C. has requested Mr. Heath (who had approached the Council on the question of E.L.) to name his terms for public lighting by electricity.

London.—L.C.C.—It has been decided to grant the loan of £2,000 asked for by the Woolwich B.C., to enable it to purchase electrical fittings for supply on hire.

The adjourned report of the Theatres and Music Halls Committees, as mentioned in our issue of February 2nd, was considered on the 13th inst., and the recommendations were adopted.

The Education Committee, in reporting on the lighting of the L.C.C. school building at Brixton, expressed the opinion that as gas had been unsatisfactory, the premises should be lighted by electricity by the installation of a set of about 35-KW. capacity. It was estimated that the total cost, including wiring and lamps, would amount to £2,250, and the Committee recommended the Council to sanction this expenditure and invite tenders for the execution of the work. A member having suggested the use of power gas in the building, the consideration of the recommendation was postponed for a week.

Bethnal Green.—The B.C. has decided, owing to several authorities being willing to supply electrical energy in bulk, to abandon its scheme for establishing a generating station. The Electricity Committee has considered the account of Mr. Hammond, the consulting engineer; the amount is £3,222 12s. 6d. The fees of Mr. Hammond include the professional fee for projected work at Derby Place, which site had to be abandoned, and also the fee relating to the station and works at and supply from, the Marion Square site. Mr. Hammond has expressed his willingness to lessen the cost to the Council as the work will not be reproductive. He has, however, refused to accept the sum which the Committee was prepared to recommend the Council to pay. The Committee advises the Council to offer him £2,100 in settlement of his account, subject to his giving credit for £500 already paid on account of the same services; also that he in consideration of this sum, release the Council from its existing contract. It has also recommended the Council to support the L.C.C., the Hackney, and the Shoreditch and Stepney Electricity Bills, and to present petitions in their favour.

Stepney.—The B.C. is to apply to the London County Council for a loan of £10,000 for E.L. purposes.

Paddington.—The B.C. has decided to petition against the L.C.C.'s Electricity Supply Bill.

Woolwich.—The B.C. has decided on the recommendation of the Electricity Committee to defer the question of the appointment of a successor to Mr. J. B. Mitchell, the borough electrical engineer, until the accounts of the electricity undertaking and Plumstead destructor are made up to date. The accounts staff and books of the electricity department are to be transferred to the borough treasurer's department, so that he may supervise the bringing up to date of these accounts.

Islington.—The B.C. has decided to purchase a mechanical stoker, supplied on trial by the Erith Engineering Co., at a cost of £350.

Fulham.—Ellbrook Common, now lighted by gas, is to be lighted by the B.C. by means of Nernst lamps at a cost of £270.

Marylebone.—Application is to be made to the L.C.C. for an advance of £48,545 for E.L. purposes. The electricity revenue account for the quarter ending December 31st shows that 1,524,976 units were sold during the three months at an average price of 5·05d., the total amount realised being £32,133, while the income from meter rents was £736. The working expenses amounted to £8,866, leaving a balance of £24,287 to meet interest on loans, sinking fund, &c. In a footnote to the account it is explained that the December quarter represents approximately 33 per cent. of the annual output under normal conditions. Therefore the standing charges should be increased by 33 per cent. This gives a total charge per unit sold of 1·583d. The figures are approximate.

City.—We understand that the Streets and Special Joint Committee of the Corporation intended yesterday to present a report recommending the Council to oppose the electricity supply schemes, including the L.C.C. (Electricity Supply) Bill, the Administrative Bill, and those of a number of private companies, and also to advise the Government to appoint a Royal Commission to inquire into and report on the whole question, this being similar to the decision of West Ham.

L.C.C. Power Supply.—The Council of the London Chamber of Commerce has this week considered the Bills promoted by the L.C.C. for the supply of electricity in bulk throughout the metropolis, and has resolved: "That this Council, having considered the London County Council electrical power scheme, is of opinion that it is most undesirable, in the interests of the commercial and trading community (and calculated to destroy private enterprise), that the power to supply electricity in bulk should be placed in the hands of the London County Council or in the hands of any private monopoly."

Poplar.—Mr. J. Horace Bowden, the B.C. electrical engineer, is of opinion that the L.C.C. Bill should be modified as follows:—Sub-Sec. 3 should, he holds, be eliminated, as it relates to supply to the buildings of the Council, and thus puts the L.C.C. in direct competition with the authorised distributor. On Sec. 12, he suggests that where large sums have been spent in laying ducts for the purpose of carrying H.T. mains, &c., these should, if not required by the existing undertakers, be used by the County Council where practicable, at a rental. This also applies to sub-stations. Sec. 26 appears to exempt the County Council from the Building Act. It is under this section, trying to evade its own Building Act, which considerably handicaps existing undertakings, and had on many occasions caused unnecessary expense in enforcing brick chimney stacks, and disallowing ferro-concrete buildings. Sec. 35 should be altered to prevent the C.C. supplying in competition with authorised distributors. In Sec. 43, revision of prices charged, he suggests a maximum price being fixed. The General Purposes Committee has decided, subject to the usual sanction, to present a petition in opposition to the Bill to secure these amendments.

Hammersmith.—On the recommendation of the electrical engineer, the Council has decided that the transformers at present in use shall be replaced as opportunity permits by new ones of modern design at current contract rates; 16 transformers are to be replaced at once at a cost of £665, less the value of the material of the old transformers, estimated at £305.

Maryport.—The U.D.C. on February 7th decided to oppose the Cumberland Electricity Bill.

Newport.—Two principal thoroughfares are to be lighted by Nernst lamps, at a cost of £144. The Electricity and Tramways Committee has been setting aside 2½ per cent. of the tramway traffic returns to meet claims for compensation, and a sum of £1,000 has been thus accumulated. It has been decided to reduce the rate to 2 per cent.

Newcastle-on-Tyne.—The City Council on the 7th inst. considered a report relative to the Newcastle Electric Supply Co.'s (Additional Powers) Bill. The report stated that provision was made in the Bill for extending the company's area of supply, so as to include the Borough of Tynemouth and the company was endeavouring to deprive the Corporation of its power to purchase, at the expiration of 31 years from July, 1891, the company's undertaking in Newcastle. The company sought to be exempted from the obligation to supply electricity to a person having a separate supply, unless such person agreed to pay charges not authorised by the company's Act or prov. order. The company was also endeavouring to repeal those provisions of its Act which prohibited the supply of energy beyond the area of supply. This would enable the company to supply electricity in Benwell and Fenham, the E.L. undertaking of which districts belongs to the Corporation. The Town Improvements and Streets Committee thinks there is no necessity for any further powers, and that these and other powers sought by the Bill would have serious and injurious consequences. The Bill is to be opposed by the Newcastle Corporation.

Ogmore and Garw.—The U.D.C. has resolved to promote a Bill to acquire the Ogmore Valley E.L. undertaking.

Orrell.—The B. of T. has deferred consideration of the revocation of the U.D.C.'s E.L. order for a year.

Rugby.—The U.D.C. has reduced the price of energy for lighting as under:—First 500 units per quarter, 5d. per unit; beyond, 4½d.

Scottish Notes.—Messrs. J. and J. L. Herd contemplate putting down an electrical installation at their Dunnikier Collieries, Fife, for pumping purposes.

A correspondent says that a new power syndicate has been formed, under the title of the North of Scotland Power Syndicate, and has headquarters in Aberdeen. The consulting engineers are Messrs. Thompson & Wilson, Edinburgh.

Sevenoaks.—A deputation from the U.D.C. recently waited upon the B. of T. and pointed out that the holders of the prov. order had done nothing towards bringing the E.L. to the town within the specified time. It was reported at the meeting of the Council on February 7th that the B. of T. would communicate with the promoters with a view either to stir them to immediate action or to terminate the order after reasonable notice.

Shropshire, Worcestershire and Staffordshire Electric Power Bill.—The Wolverhampton T.C. has decided to oppose the measure vigorously, on account of the provisions of the present Bill enabling the company to enter into direct competition with the Corporation by the powers sought to supply energy directly to power consumers in the borough, and also, subject to some limitation, for lighting and other purposes. The Bill is to be opposed with a view to obtaining the exclusion of Wolverhampton from the proposed enlarged area of supply, and generally for protecting the interests of the Corporation. The Walsall T.C. and the Tettenhall U.D.C. have also decided to oppose the Bill.

Somerset and District Electric Power Co.—In 1903 the Bristol Corporation strongly opposed certain proposals contained in the Somerset and District Electric Power Bill then before Parliament, but authority was given the promoters to enter the civic area and supply customers under severely restricted conditions. This subject came before the Bristol T.C. on Tuesday last. It is contended that the statutory period to put the Act into operation has elapsed, and that districts affected may apply to the Board of Trade for an order declaring that the Act has ceased to be operative. The circumstances were explained in a speech in which the chairman of the Electrical Committee, Ald. Pearson, moved for a reference to his Committee with this object. He said the Act applied to parts of Somerset, Gloucester and Wilts. It gave the company certain rights of entering into Bristol, but these were comparatively small. Under the 69th Section, if, two years from the date of passing of the Act, the company had not commenced work, and if within four years of the date it had not provided generating stations, &c., the districts affected could apply to the B. of T. to have the Act, as far as they were concerned, abrogated. The rights of entry into Bristol were such that a customer who could go to the B. of T. and show that the city Corporation was not in a position to supply him at a reasonable price, could obtain a supply from the company when the company had started works. The city had the right to arbitration before the B. of T. over every customer with whom the question arose. The Council approved of the Electrical Committee taking into consideration an application to the B. of T. to abrogate the Act.

South Africa.—Cape Town.—The Corporation Electric and Waterworks Committee of Cape Town has received a statement dealing with the revenue and expenditure of the E.L. Department for the 10 months ended October 31st, 1905, of which the following is an epitome:—The revenue accrued during the 10 months was £58,376, of which £5,950 was outstanding, the estimate for the year being £70,436. The working expenses during the period were £49,635, the estimate for the year being £65,607. The expenditure on extensions of private connections and two-rate cables for new consumers during the period amounted to £1,458.

Spennymoor.—The E.L. Co. has intimated that from March 31st next the price of electricity will be reduced from 6d. to 4d. per unit.

Tunbridge Wells.—It was reported at the meeting of the T.C. on February 7th that the electrical engineer, constantly receiving applications for energy from large houses just outside the borough, had urged upon the Lighting Committee the importance of extending the area of supply. The Committee, however, intimated that it was not desirable to apply for Parliamentary powers to enable it to supply outside the borough. People living outside the town did not pay the rates and took no responsibility, while there was a company which was applying for powers to cover the outside area.

Tynemouth.—A special meeting of the T.C. was held on the 10th inst. to consider the Bill for extending the area of supply of the Newcastle-on-Tyne Electric Supply Co. The Bill proposes to transfer to that company the undertakings authorised by the Whitley and Monkseaton E.L. Order, 1901, and the Seghill Earsdon and Tynemouth (Rural) E.L. Order, 1902. The Mayor (Alderman J. P. Spencer) said the Bill seriously affected the interests of the ratepayers, and it was necessary to oppose the Bill to the utmost. The Corporation was alarmed at the attempt, as it imagined, to wrest from the Corporation duties which, at a cost of something approaching £100,000 of the ratepayers' money, it had entered upon. A resolution was passed to oppose the Bill.

Walsall.—The Electricity Committee has recommended the T.C. to apply for a loan of £13,000 for electricity purposes.

Wath.—The U.D.C. has decided to consider the question of establishing electricity works if the gas company refuse to reduce the price of gas.

West Ham.—The Corporation resolved on Tuesday to petition the Government to appoint a Royal Commission to inquire into the whole question of the electricity supply of London and the neighbourhood, and that, pending the report of such Commission, all Bills dealing with the matter be held over. The charge for energy for lighting is to be reduced as from March 31st next from 4d. to a maximum of 3d. per unit, and for power to a maximum of 1d. per unit, consumers using power to be allowed to use up to 10 per cent. for lighting purposes. The Stratford Co-operative Society are to be supplied under a 12 months' contract at 2½d. per unit. In future there is to be an annual contract for motors and accessories; this will enable the Council to keep some in stock. Owing to the load on the traction feeders this winter having equalled the capacity of the traction generating plant, new machines, consisting of a 1,500-kw. turbo-generator and a 500-kw. motor-generator, are to be obtained at an estimated cost of £12,000.

West Hartlepool.—The electrical engineer recently reported on the necessity of providing additional generating plant at the electricity works. To meet next season's demand, he stated that there was sufficient boiler power to run an additional 500-kw. set. The T.C. has adopted this suggestion, and decided to apply to the L.G.B. for £5,900 to carry out the work, the estimated cost being made up as follows:—Triple-expansion engine and generator, £4,500; extension to building, £1,350.

Whitefield.—Salford T.C. has informed the U.D.C. that it is not prepared to supply energy to the district for lighting purposes.

Wimbledon.—The T.C. has decided to fix prepayment electricity meters in premises let upon short-term tenancies, and to supply energy at 5d. per unit.

Willesden.—The U.D.C. takes a supply of energy in bulk from the North Metropolitan E.P.D. Co. at the price of ·9d. per unit. A large power consumer of the Council having asked for a supply at 1d. per unit, it has been resolved to enter into a supplementary agreement with the company giving the Council optional bulk supply charges.

York.—At the meeting of the T.C. on February 8th, Ald. Purnell asked if the Electricity Committee made any profit on work done in wiring private houses and buildings for the E.L. In reply, Ald. Scott said "they endeavoured to make about 20 per cent. profit." Ald. Purnell said "he was told that nothing was made out of private wiring. It was all very well saying 10 per cent. was put on, but he believed it could be shown that in some cases it was done at a loss, whilst they were preventing other people from getting the work to do."

TRAMWAY AND RAILWAY NOTES.

Argentina.—The Sociedad Belga-Argentina de los Tranvias de Buenos Aires has presented to the Intendencia Municipal of Buenos Aires a statement of the terms of the contract entered into with Mr. Gaston Roux for the transference to the latter party of the contracts held by the former for electric tramways in Buenos Aires.

The Intendencia Municipal of Buenos Aires has granted a concession to Senores Urdaniz y Cia for the establishment and exploitation of a network of electric tramways.

Birkenhead.—At the monthly meeting of the T.C. Dr. Pearson alluded to the recent tramway accident at Liverpool, and stated that all cars that ran on the two chief gradients in Birkenhead, Pearson Road and Ball's Road East, were provided with

slipper brakes. These had been recommended by the B. of T. They had now adopted a double slipper brake, the invention of one of the Corporation staff, which acted on both ends of the car, so that if one happened to fail the second would act.

Bournemouth.—The T.C. has finally decided not to run cars on Sundays.

Burnley.—The T.C. has decided to include in the Corporation Bill to be promoted in 1907, the extension of the electric tramways to Briercliffe.

Cavehill and Whitwell.—On the 13th inst., the Cavehill and Whitwell Electric Tramway, which was recently converted from horse traction by Messrs. J. G. White & Co., London, was formally opened. The line runs from the end of the Belfast Corporation Tramway, Chichester Park, to Glengormley, about three miles, through some of the most beautiful suburbs of Belfast. The system has been in existence for over 20 years. Power is obtained from the Belfast Corporation's electricity works.

Cheshire Light Railways.—A committee has been appointed to confer with the authorities and promoters *re* the extension of time for commencing the Northwich to Warrington Light Railway. The promoters ask for an extension to permit of the compulsory purchase of land, and the County Council and several other authorities have served notices of opposition to the proposed extension. The Light Railway Commissioners have intimated that unless a basis of agreement between the objectors and the promoters can be arrived at, a local inquiry must be held.

Croydon.—The formal inspection of the new tramway line which continues the Croydon system to Penge and Anerley took place on Friday afternoon last. There is now a regular service of cars running into Penge, the line being completed up to the Crystal Palace with the exception of about 20 yards. The frontage owners along this length object to the widening of the road, and it is feared tha a single line will have to be made, thus making a dangerous bottle neck. Outside the entrance to the Crystal Palace at Penge there is a railway bridge, and at that point the road has had to be lowered 3ft., adding to the awkwardness of the gradient. The track throughout will be paved with wood.

East Ham.—Application is to be made for sanction to borrow £1,050 for doubling the tram track.

Folkestone.—The T.C. has sanctioned the Bill which is being promoted by the National Electric Construction Co. for powers to make lines connecting Folkestone with Cheriton, Sandgate, and Hythe.

Gildersome.—The U.D.C. on Monday unanimously resolved to oppose an application by the British Electric Traction Co. to the B. of T. to prolong the time limit for the completion of the light railways authorised by the Morley and District Light Railways Order, 1901, until March 4th, 1907.

Glasgow.—On Saturday night, as a car was proceeding along one of the leading thoroughfares, the driver was seized with sudden illness and fell senseless on the platform. The conductor immediately went to his assistance, and turned off the power. Before this was achieved, however, the car collided with a spring van and knocked the van through a shop window. Fortunately no one was injured. The driver quickly recovered after being medically attended.

Houghton-le-Spring.—The B. of T. has granted a year's extension for completing the Houghton and District Electric Tramways.

India.—Nagpore.—An amended licence has, according to the *United Provinces Gazette*, been granted to Messrs. Crompton and Co., of Chelmsford, for the installation of electric tramways.

Jarrow.—The B. of T. has informed the T.C. that it has granted an extension of time until December 17th next to the B.E.T. Co. for carrying out the light railway order.

Kew Bridge.—Owing to the opposition of the Middlesex and Surrey County Councils, the London United Tramways Co. has abandoned its proposal to run cars over Kew Bridge.

Kingston (Surrey).—According to the *Daily Telegraph*, a trial run over the new tramway lines laid down in Kingston was made on Sunday night. Two new cars, each capable of accommodating 74 persons, left the depôt of the London United Tramways Co. at 11 o'clock, one containing Sir J. Clifton Robinson, the managing director, and other officials, and the other a gang of workmen. After passing along the Middlesex lines, Kingston Bridge was reached, and the pioneer car made the crossing, being the first electric car to run over any of the Thames bridges. The whole of the Kingston section is not yet complete, a line from London Road to Richmond Park Gates being still under construction; but it is expected that the completed lines will be opened to traffic before long. The route is also being extended through Malden, Raynes Park, and Wimbledon, and when finished will form a junction with the London County Council service at Tooting.

Llanelly.—The Light Railway Commissioners held an inquiry last week into the proposal to construct a light railway in the district. Opposition was raised by Messrs. Nevill Druce & Co., who own a railway crossing the line in question, but terms were arranged.

Liverpool-Southport Railway.—Reference was made at the half-yearly meeting of the Lancs. and Yorks. Railway Co., at Manchester, to the electrified section between Southport and Liverpool. The chairman (Sir Geo. Armytage) said they found, after a full year's experience, that the cost of electric working, as they had expected, was, when proper allowances were made for the depreciation of the more costly plant, slightly higher per train-mile run. With this result, however, the directors were quite satisfied, as they had been able to do a much greater amount of work and to give a very much improved service to the public. They now contemplated some additions which would enable the company to deal with the rapidly-growing traffic. Since the last meeting the electric system had been coupled up with the Liverpool Overhead Railway at Seaforth. They hoped before long to run a complete service of trains over that line to and from Dingle. Commenting upon the heavy rates which the company were burdened with, Sir George urged every shareholder to put a check on this ever-growing taxation, and, in conclusion, said it was a great satisfaction to feel that their policy in keeping everything up to the mark had enabled them to cope with the increased traffic when it came, with the result that their capital expenditure had never been so low as it was now, and their revenue expenditure compared most favourably with that of other companies.

A correspondent informs us that, the experiments having proved satisfactory, the Lancashire and Yorkshire Railway Co. are now running through-coaches from Southport, on their electrified line, to Dingle, on the Liverpool Overhead Electric Railway. Each of the new cars is 45 ft. 9 in. long × 9 ft. 6 in. wide, and accommodates 20 first-class and 50 third-class passengers. Two-car trains are arranged on the multiple-unit system of control. The cars have had to be specially constructed by reason of the fact that the overhead railway is carried on an exceptionally light structure. Electric lighting and heating are arranged on the cars throughout, giving three gradations. Ample ventilation is provided. The cars are comfortably furnished, and substantially, though not heavily, built. The under-frame is entirely of steel, with non-inflammable insulating material between the main members and the coach flooring. The exterior panels are all of aluminium sheeting.

London.—L.C.C.—The Highways Committee in announcing the opening to traffic of the New Cross—Lewisham tramways, stated that the B. of T. had intimated its intention of revising the regulations made by the Board, for the purpose of giving effect to Col. Yorke's recommendations as to speed.

The Highways Committee also stated that as soon as the Greenwich station was completed, it would not be necessary to continue the temporary arrangements made with the City of London E.L. Co. for the supply of power at the company's station at Bankside. It was therefore proposed at an early date to arrange for the transfer of motor-generators from Bankside to certain of the Council's sub-stations, and to obtain switchgear from the General Electric Co. at a cost not exceeding £2,300 for working this plant in connection with the other machinery. It was also proposed to expend £400 on the purchase of a starting motor-generator from Messrs. Dick, Kerr & Co. in conjunction with the same plant.

Kensington.—The B.C. has refused its consent to a proposal of the L.C.C. to construct a tramway along Church and Silver Streets, leading through the centre of Kensington, regarding it as wholly unnecessary.

Manchester.—The men employed on the Manchester tramways have applied to the committee for payment at the rate of time and half for Sundays, Christmas Day and Good Friday, and the committee having refused to grant it, a mass meeting of the men is being organised for the purpose of deciding what further action they shall take in the matter.

North-Eastern Railway.—At the meeting of the North-Eastern Railway Co. at York on the 9th inst., Mr. John Lloyd Wharton, the deputy chairman, who presided, made a lengthy reference to the electrical traction on the suburban lines in the neighbourhood of Newcastle-on-Tyne. He said that in the last half of 1903, with steam traction, they had 2,844,000 bookings, and in the last half of 1905, with electric traction, they had 3,548,000, an increase of, in round figures, 25 per cent. In 1903 the gross amount of money earned with steam traction was £129,000; and in 1905, with electrical traction, the gross amount of money earned was £151,000, and they had run in 1905 twice as many train-miles as they had in 1903. They hoped and believed they had added very materially to the comfort and convenience of that area which electric traction now served. In 1903, to earn the £129,000 to which he had referred, the running expenses amounted to £42,761, while to earn the £151,000 it cost £47,799, which was only £5,000 more, to do twice the work in 1905 that they did in 1903. He thought that those figures were not only interesting, but satisfactory for the shareholders to hear. He should give the figures in another way, as many persons were interested in train-mileage cost. In the electric traction on the 31 miles of suburban railway in the Newcastle district they had practically doubled the train-mileage, and doubled the accommodation of the public, and the running cost per train-mile, allowing for depreciation of stock, &c., had been with electric traction about 9d. per train-mile as compared with 1s. 5½d. per train-mile under steam conditions. They had run smaller trains, but there were more of them. They were thus able to serve the public better, and at the same time to make a better profit for themselves. At first there was much apprehension as to the danger of electric traction, but he was glad to say that up to the present time they had only had three fatal accidents. That must be a matter of solid satisfaction to all who were interested in the matter.

Oxford.—The Tramway Co. has submitted to the T.C. proposals for electrically equipping the tramways. The company asks the Council to consent to its application for powers, and offers to pay the Council £300 per annum rent, the Council to have the option of purchase at the end of 7 or 14 years.

Southport.—The T.C. has decided to petition against the Southport and Lytham Tramroad Bill, 1906, on the ground that the extension of time by three years, which is asked for, would be prejudicial to the economical development of the Corporation estate.

Walsall.—The working of the Corporation tramways for the year shows a net profit of £3,894, as against one of £2,269 for the previous year. It is strongly recommended by the Tramways Committee, that the whole of this profit be transferred to the reserve fund. The average earnings per car-mile are 9·856d., against 9·459d. in the previous year. The total increase in the income is £793.

Wigan.—A poll on the question as to whether the T.C. shall acquire the Standish and Coppull section of the proposed Preston, Chorley and Horwich tramways has resulted in an overwhelming majority against the scheme, which involved an expenditure of about £30,000.

TELEGRAPH AND TELEPHONE NOTES.

Afghanistan.—According to the *Financial News*, the telephone is making great strides in Afghanistan. The system is now being extended so as to bring the most distant stations into communication with each other. These include Ghanzni, Kandahar, Herat, Badakshan, Jelalabad, Khost, &c., and there will also be a connection with Turkestan. Much of the necessary plant is already stored in Kabul, and the Ameer recently placed a large order for telephone equipment in Calcutta. This activity shows that the Ameer has turned his attention towards the question of communications.

Canada.—A special committee of the Legislature is to be appointed to investigate fully the telephone question. It will be empowered to examine persons and officials under oath in order to secure data for the House. This is probably the first step towards a Government telephone system.

Colombia.—Official advices state that the cables between Panama and Buenaventura, and Buenaventura and St. Elena, are both interrupted, cutting off the Republic of Colombia from telegraphic communication by all routes.

Frankfort-Vienna.—The new telephone line just opened between Frankfort-on-Main and Vienna has a total length of 511 miles, and is therefore 174 miles longer than that between Frankfort and Paris, which is 337 miles long. The charge for three minutes' use has been fixed at 3s., and this rate will be tripled for urgent messages during the busy hours of the day. It is stated that conversation is tolerably well heard between the two cities.

Wireless Telegraphy.—We learn from the daily Press that a possibility now exists of the early inauguration of a commercial wireless telegraphic service between the United Kingdom and America. The preliminary difficulties, it is again stated, have been overcome, and Mr. Marconi once more hopes that the service will be at work in the late autumn. The erection of a station on the west coast of Ireland is all that remains to be done. In agreement with the Canadian Government the rate is still fixed at 6d. per word.

It is stated that the staff at the Ferrol wireless station is composed of Spanish Government telegraphists, and is under the supervision of the Government authorities, and that there is no foundation for the statements that the station has been put to improper uses. The *Diario Ferrolano* also states that the German Consul has never made use of it, although it was fitted up by Germans.

West Indies.—The Direct West India Cable Co. is advised that cable communication between Jamaica and Puerto Rico has been restored, and that cablegrams can again be sent to all the islands and British Guiana.

Hammersmith.—A letter was read at the B.C. meeting last week from the Postmaster-General with reference to the Council's consenting to the placing of certain overhead wires, on condition that the same be used solely for fire alarm purposes; the Postmaster-General refused to accept the condition, and referred the Council to the case of the Postmaster-General *v.* the Mayor, &c., of the City of London, heard in the Court of the Railway and Canal Commission in February, 1898. In this case it was held that it was not within the competence of a Corporation as a road authority acting under the Telegraph Acts of 1863 and 1878 to raise any objection to an application by the Postmaster-General for leave to lay telegraphic lines, unless the objection was of a kind which concerned it as a road authority, and that an objection relating to the use of the wire by a particular company was not a reasonable objection. Having regard to the foregoing decision, the Council resolved to waive the condition attached to its consent.

Norwegian Telegraphs and Telephones.—The telegraph and telephone system of Norway was represented at the end of the year 1904 by 13,827·9 kilometres of line and 99,477·4 of wire, showing an increase of 288·7 kilometres of line and 5,221·9 of wire. Posts and insulators caused 619 interruptions, broken wires 588, crossing of wires, &c., 1,266, and 370 were due to other causes. Telegraph offices numbered 763, there being an increase of 47. There were 1,051 persons engaged in the telegraph service, and 1,430 in the telephone service. Telegrams numbered 2,355,633, showing an increase of 50,661, and there were 368 claims for refund of tolls, and 7,024 undelivered telegrams. Telephonic conversations numbered 55,023. Revenue from the telegraph and telephone services amounted to about £180,753. Expenses amounted to about £133,351, leaving a balance to the good of about £47,243.

Post Office Telegraphs.—The new Postmaster-General has announced that he is prepared frankly to recognise any duly constituted association or federation of postal servants. He is willing to receive representations from the members or representatives of the association if they be in the service, or through its secretary (whether he be a member of the service or not), on matters relating to the service as a whole, or on matters affecting the class or classes of servants of which the association is representative. Representations from an association will carry much greater weight if made by those members of it who are directly affected by, or interested in, the question at issue, and who, therefore, possess personal and practical knowledge of the question.

Telegraphic Interruptions and Repairs:—

CABLES.	INTERRUPTED.	REPAIRED.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	..
Dominica-Martinique	May 7, 1902	..
St. Lucia-Martinique	May 7, 1902	..
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	..
Cayenne-Pinheiro	Aug. 18, 1902	..
Port Arthur-Chifu (Closed)	Mar. 7, 1904	..
Jamaica-Colon	Jan. 5, 1905	..
Cadiz-Tenerif	July 20, 1905	..
Tarifa-Tangier	Jan. 18, 1904	..
Puerto Plata-Martinique	Oct. 30, 1905	..
St. Thomas-St. Kitts	Dec. 28, 1905	Jan. 26
Bolama-Bessao	Jan. 19, 1906	Feb. 10
Jamaica-Puerto Rico	Feb. 1, 1906	Feb. 8
Panama-Buenaventura	Feb. 1, 1906	..
Buenaventura-St. Elena	Feb. 1, 1906	..
Vladivostock-Nagasaki	Feb. 7, 1906	..
LANDLINES.		
Puerto-Barrios	Aug. 28, 1902	..
Communication with Brazil *via* Galveston	July 18, 1905	..
Communication with Alaska *via* Seattle	Jan. 17, 1906	..

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—February 20th. Stores for the electricity department. See "Official Notices" February 9th.

Bermondsey.—February 22nd. Stores for the B.C. electricity and destructor works. See "Official Notices" February 9th.

Bilston.—March 12th. Electric lighting of the new schools now being erected at Stonefield. See "Official Notices" February 9th.

Cardiff.—February 16th. Cooling towers, electrically-driven pumps, pipe-work, &c., for the Corporation Roath Power Station. See "Official Notices" January 26th.

Christiania.—February 21st. The Acting British Consul-General at Christiania has forwarded to the Commercial Intelligence Branch of the Board of Trade particulars of a call for tenders for the supply to the Norwegian Telegraph Department of the following material:—

Three tons 1·25 mm. bronze wire; 500 metres 26-pair branch cable; 25,000 metres double tar wire, spun together; 200,000 metres double wire; 900 kilos. sal-ammoniac; 2,700 kilos. copper vitriol; 1,000 kilos. gum arabic; battery zinc and Morse paper.

Tenders from British firms should be lodged in Christiania by their properly accredited agents by February 21st. Specifications, &c., (in Norwegian) may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, E.C.

Dover.—February 16th. One 350-KW. combined steam generator set for traction purposes for the Electricity Department. See "Official Notices" January 26th.

Dublin.—March 1st. Electrical works and supplies for buildings of the Commissioners of Public Works. H. Williams, Secretary, Office of Public Works, Dublin.

(*Continued on page* 263.)

THE MANSFIELD ELECTRICAL UNDERTAKING.

Situated in the heart of the ancient forest of Sherwood, the town of Mansfield is of interest on the dual grounds of antiquity and modern industry. Its population of 28,000 inhabitants find employment in a variety of industries, including iron founding, engineering, cotton doubling, the manufacture of hosiery, boots, &c., and in the neighbourhood coal mining and the quarrying of the celebrated Mansfield moulding sand.

Fig. 1.—View of Electricity Works, Showing Incline to the Destructor.

The present article deals with a prominent feature of Mansfield's municipal development, viz., the Electricity and Refuse Destructor Works, which were opened on June 17th, 1903, and which adjoin their ostensible, though municipal, rival, the gas works.

Architecturally, the buildings, which include engine, boiler and destructor houses, together with a battery room and spacious offices, leave little to be desired.

The destructor and boiler houses adjoin each other, although they are, naturally, distinct: the destructor boilers, which have a nominal working pressure of 200 lb. per sq. in., supply steam to the main steam range through a reducing valve.

The destructor plant is designed to cope easily with the 200 tons or so per week of refuse collected by the sanitary department. It consists of three twin cells of Messrs. Heenan & Froude's back-feed type provided with hot fan draught: the refuse is tipped into a hopper behind the furnaces, and is raked on to the latter from the clinkering floor in front.

The twin cells are separated by a low central wall, and are fired alternately, the arrangement of the flues being such that the gases rising from the furnace which has been freshly charged are thoroughly mixed with those coming from the adjoining furnace, in which combustion has taken place and therefore a high temperature exists.

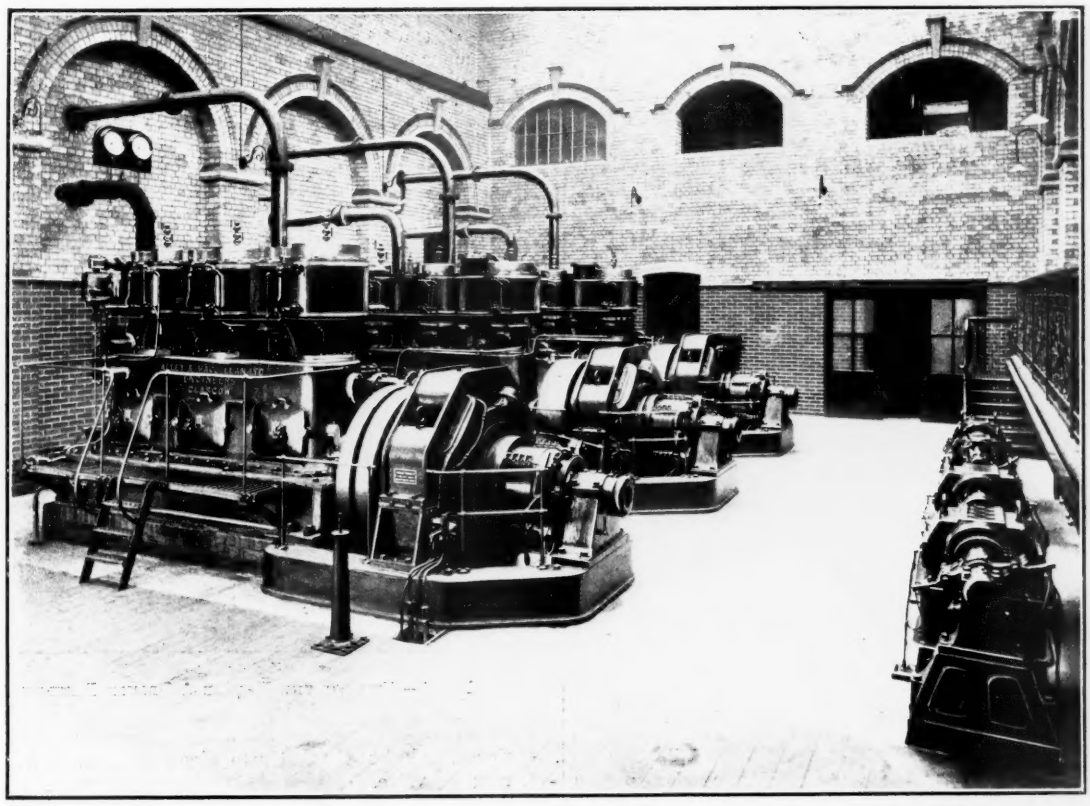


Fig. 2.—General View of the Engine Room.

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The gases from the furnaces pass through the two Babcock & Wilcox water-tube boilers, shown in fig. 5, of the destructor house; each boiler has 1,200 ft. of heating surface, and under present conditions they easily provide steam for plant of 200 KW.

The fans for the hot blast, which are situated on the tipping platform, are motor driven: they discharge through an air heater in the flues to the underside of the destructor grates.

The adjoining boiler house contains three steel Lancashire boilers, made by Messrs. Musgrave, of Bolton.

Each boiler is 30 ft. long × 8 ft. in diameter, and is capable of evaporating 8,000 lb. of water per hour, to steam at the working pressure of 160 lb. per square inch.

The boilers are equipped with Proctor mechanical stokers, which are motor driven and are fed by hand from the coal bunkers, situated outside the boiler house, under the tipping road. A view of the coal-fired boiler house is shown in fig. 3. The fuel used is a cheap grade of smudge, costing some 3s. 3d. per ton delivered. A Green economiser of 96 tubes is installed in the main flue, the customary by-pass being provided, and the flues from both the destructor and the boiler house lead into an Alphons Custodis chimney, 150 ft. in height, situated centrally but outside the two buildings.

The boiler-feeding plant at present consists of two Hall compound double-acting steam pumps with a Koerting injector as a stand-by, situated in a pump room opening out of the boiler house. A Crompton-Worthington electrically driven pump is on order to supplement the present pumps.

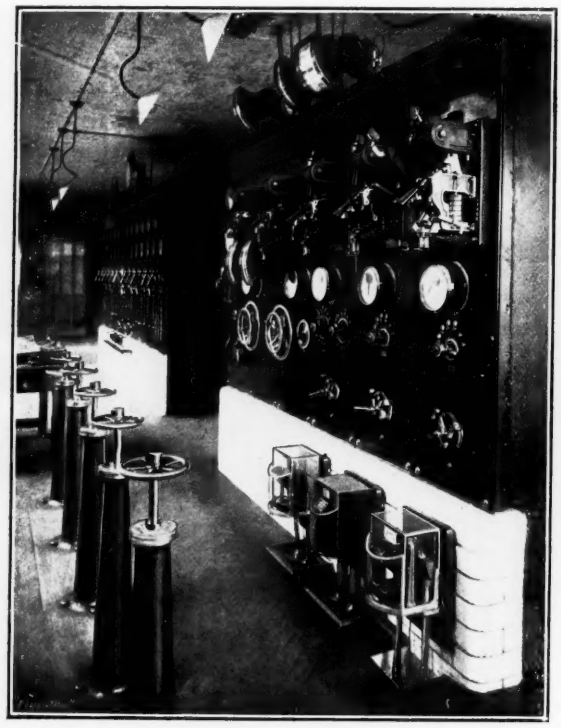

Fig. 4.—The Generator and Feeder Switchboards.

The pumps draw from a feed-tank situated under the floor, and deliver either through the economiser or direct to the boilers, a duplicate feed range being provided.

The feed tank is filled from a general storage tank erected over a portion of the boiler house, and supplied from the river, the water passing through a Pulsometer filter on its way to the feed tanks, which effectually removes all grit and sediment.

After experimenting, Mr. Hewlett, the borough electrical engineer, has adopted a mixture containing approximately one-fifth town water as the best water for his boilers.

Fig. 3.—The Boiler House.

It is, of course, necessary that the destructor and coal-fired boiler feeds should be kept distinct, owing to the varying steam pressures in the two cases. In either case a warm feed is assured, owing to the feed-water in the tank being heated by means of a heating coil fed from the pump exhausts and by the engine separator drains.

The main steam and feed pipes are of lap-welded steel, and, with the whole of the pipework and tanks, were supplied by Messrs. Crompton & Co.

The steam piping is arranged over the boilers, &c., only the 4½-in. engine branches leading into the engine room. The main header, 7 in. in diameter, is, as previously mentioned, linked to the destructor pipe range through a Forster reducing valve.

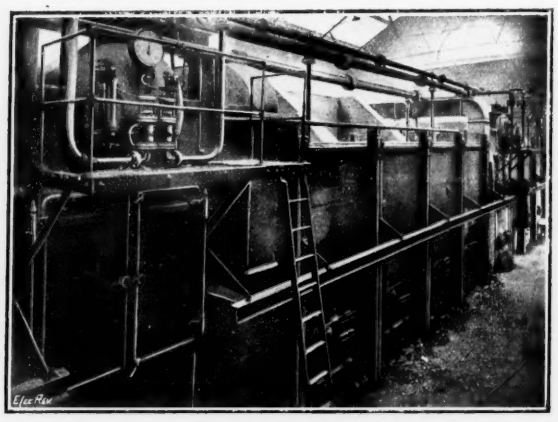

Fig. 5.—View of the Heenan & Froude Destructor.

A 3-in. auxiliary steam-pipe range is installed for supplying the steam-driven feed-pumps, which, it may be noted, are the only steam-driven auxiliaries in the station.

Turning to the engine room, three generating sets are installed; these consist of Alley & MacLellan triple-expansion enclosed three-crank engines coupled to 240-KW. Parker four-pole compound-wound generators. The engines are of the double-acting type, and are provided with forced lubrication: the normal speed of the generators is

360 r.p.m., the generating pressure, 480-600 volts, being suited for either lighting or traction purposes. The equalising and change-over switches, together with regulators

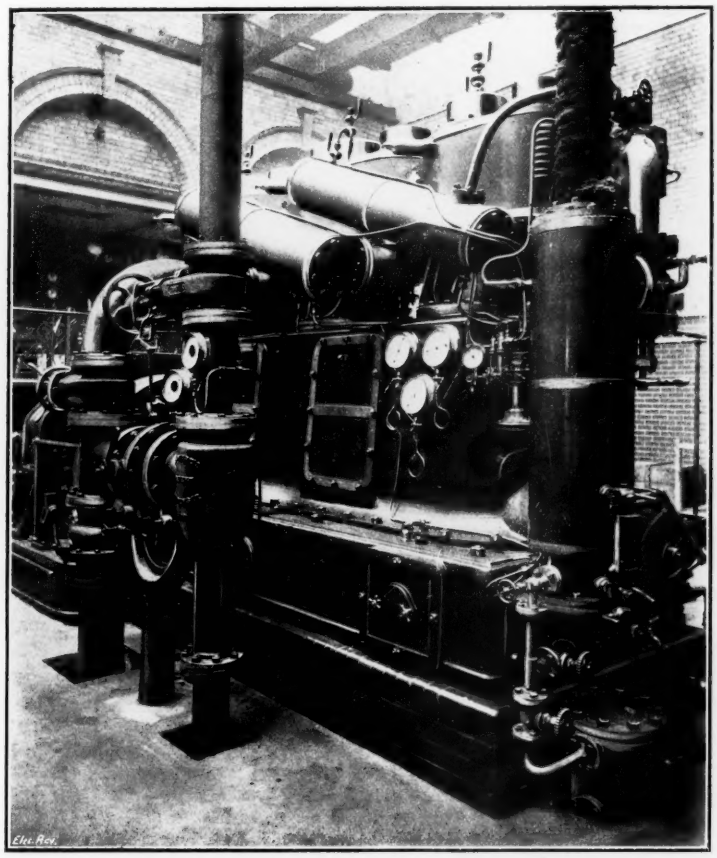

Fig. 6.—Alley & MacLellan-Parker Steam Dynamo, showing the Ejector Condenser.

for varying the compounding of the machines, are mounted on the magnet frames.

The third generating unit recently installed, which we illustrate in figs. 6 and 7, contains several improvements on its predecessors, including in the generator the provision of auxiliary or commutating poles, a constructive addition which is meeting with some favour at the present time, and which, we believe, makes a first appearance at Mansfield, as far as central stations are concerned. Among other improvements, the engine is provided with inclined receivers, and in common with the others has a Ledward ejector condenser mounted on one side, which is designed to maintain a 24-in. vacuum under normal conditions: the arrangement of the condensing plant is clearly illustrated in fig. 6.

The water for condensing is obtained from the River Maun, which flows close by.

The river is slightly dammed, and a 15-in. pipe, provided with strainer, &c., leads to a sump under the engine room. From the sump the water is pumped up to the storage tank previously mentioned, which measures 46 ft. × 20 ft. × 4 ft., and is situated over the boiler house: three Gwynne centrifugal pumps, each coupled to a 10-B.H.P. motor, with the necessary starting gear, are installed in a room adjoining the engine room, for the purpose. Each pump has a rated capacity of 20,000 gallons of water per hour. The condenser discharge is returned to the river. An alternative atmospheric exhaust is provided for the engines in view of the possible failure of the vacuum.

In addition to the generating plant mentioned, a booster set for use with the battery and a balancer are installed in front of the switchboard gallery. The former consists of a 550-volt bi-polar motor coupled to a similar generator, designed to give up to 150 amperes at 160 volts; the balancer, which will deal with 130 amperes out-of-balance current, also consists of two bi-polar machines. These, and in fact all the works motors, are arranged to work from either the lighting or traction supply as desired.

A 10-ton hand-operated overhead travelling crane, supplied by Messrs. Carrick & Ritchie, spans the engine room.

The contractors for the generating plant were Messrs. Thos. Parker, Ltd., and for the condensing plant Messrs. Johnson & Phillips, Ltd.

The switchboards are situated on a gallery opening on to one side of the engine room, but in an adjoining structure, the upper floor of which serves the purpose of a battery room. In the latter is installed a Tudor battery consisting of 292 L 17 K.W.S. type cells, arranged in tiers, and having a capacity of 1,000 ampere-hours, or 360 amperes at the one-hour rate.

The battery is utilised either on the lighting or traction supply as may be most efficient. A small milking booster is provided for adjusting individual cells.

To return to the switchboard gallery, which we illustrate in fig. 4, the near board contains three panels for controlling the three generators, each equipped with maximum cut-outs and combined minimum and reverse current cut-outs on the positive and negative sides respectively, together with watt-hour-meters for measuring the machine outputs; two further panels provide for the control of the battery,

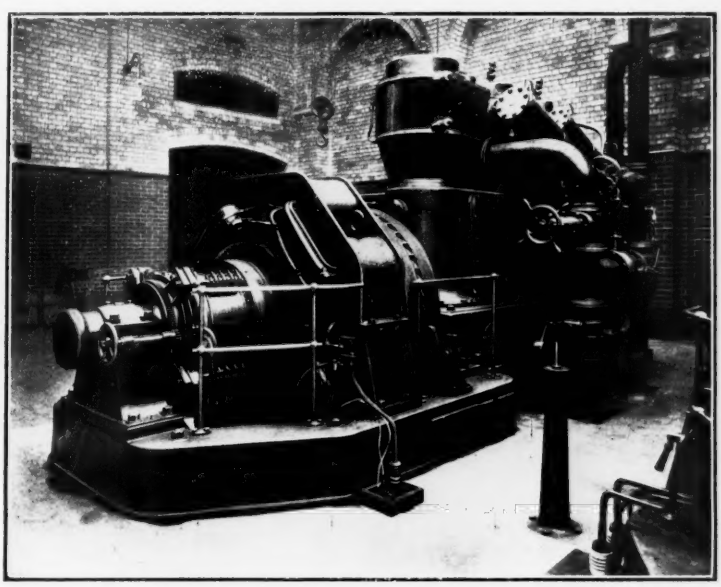

Fig. 7.—Parker Generator, with Auxiliary Poles.

which is regulated on the neutral cells, the regulating switchgear in the battery room being worked by chain gear from the battery panels, and a sixth panel, equipped with a

Barber Starkey automatic switch, provides for the booster control. The generator field-regulating resistances are controlled by hand wheels mounted on pillars situated some distance in front of the switch panels.

The feeder board, which also is shown in fig. 4, is of the plug pattern, consisting of seven panels, the central one being the neutral panel equipped with recording ammeter,

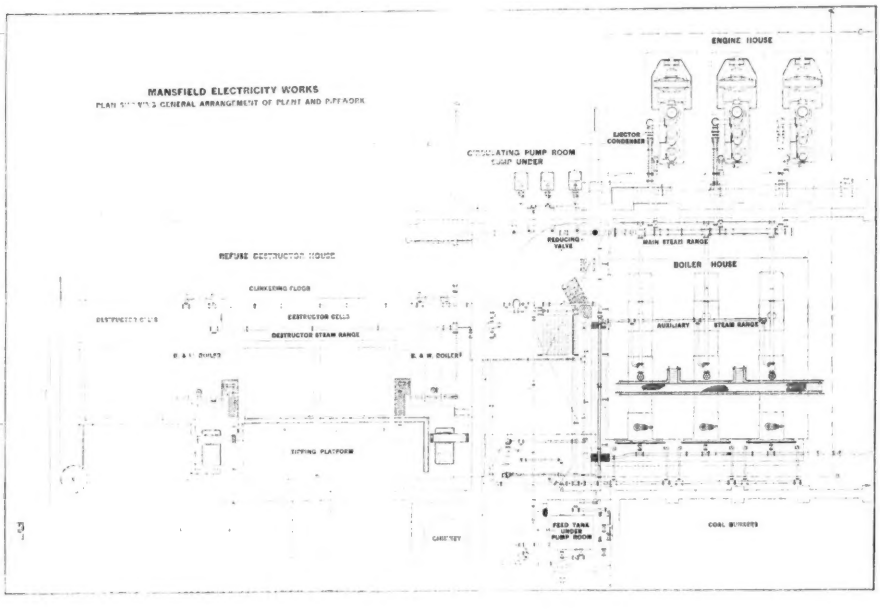

FIG. 8.—PLAN OF THE GENERATING AND DESTRUCTOR PLANTS.

cut out, &c., in the earth circuit, and the outer panels on either hand being positive and negative respectively. Four of these panels control lighting feeders, and the other two the works lighting and power circuit and the balancer; each feeder panel is equipped with an ammeter, two-way quick-break switch and duplicate fuse, watt-hour-meter, &c.

Positive, negative and spare lighting and one traction busbars are provided behind the board, the latter bar being coupled to the traction board, which is situated at one end of the gallery and arranged to control three ·15 sq. in. traction feeders leading to the local tramway company's private sub-station, some 1,600 yd. distant, from which the normal tramway distribution is carried out.

The traction panels are equipped with magnetic blow-out circuit-breakers, B.T.-H. watt-hour-meters and recording ammeters.

The whole of the switchboards and connecting cables were supplied by Messrs. Bertram Thomas.

With a view to facilitating the execution of orders from the switchboard to the two boiler houses, a bell system of intercommunication has been installed.

Behind the switch gallery is situated a suitably equipped test room, and the basement serves for a cable dividing room.

The whole of the original lighting feeders and distributors are of the Western Electric Co.'s triple-concentric lead-sheathed cable laid solid in earthenware troughing: the house services are of armoured cable, and the distribution network is fused between the feeding centres.

The equivalent 8-c.p. lamp connections at the present time amount to 25,000, and for the street lighting 40 Gilbert arc and 11 ½-ampere Nernst lamps are in use.

The local tramways, which have only recently been completed, consist of some 10 miles of route, constructed under the Mansfield Light Railway Order, 1901. The system is operated by the Mansfield and District Light Railway Co., with energy supplied by the Corporation. Views on the route are given in figs. 9 and 10.

Mr. Robert Hammond acted as consulting engineer for the combined undertaking, and his assistant Mr. Holcombe Hewlett, who supervised the carrying out of the scheme, was subsequently appointed borough electrical engineer. Under his experienced guidance the undertaking has prospered to the full extent.

To the latter gentleman we are much indebted for the facilities courteously extended on the occasion of our visit.

FIGS. 9 AND 10. VIEWS ON THE MANSFIELD TRAMWAYS.

CONTRACTS OPEN.

(*Concluded from page* 258.)

Halifax.—February 27th. A 30-35-B.H.P. motor tower wagon for the tramways department. See "Official Notices" February 9th.

Hornsey.—February 26th. Cables, junction boxes, fuse boxes, meters and cable stores. See "Official Notices" February 9th.

Ilford.—February 26th. Meters, cables, lamps, carbons, &c., for the electricity department. See "Official Notices" to-day.

Johannesburg.—March 31st. 350 street lamp fittings, 50 stays for ditto, and 600 ft. gas barrel for the T.C. See "Official Notices" to-day.

Oldham.—February 19th. Electric wiring for the New Market Hall. Specification, &c., from Clerk of Works, at the Hall.

Pontypridd.—March 3rd. Reservoir, condensing plant, cooling tower and tank, and artesian well for the U.D.C. See "Official Notices" February 9th.

Portsmouth.—March 5th. Water-tube boiler, economiser, pumps, condenser, cooling tower, and one triple-expansion 1,000-KW. slow-speed vertical generating set; switchboard alterations and additions, for the Corporation. See "Official Notices" to-day.

Rathmines and Rathgar.—February 17th. Coals, carbons and general stores for the electricity department. See "Official Notices" February 2nd.

Salford.—February 17th. Stores, &c., for the electricity department. See "Official Notices" February 2nd.

Shanghai.—February 22nd. One 800-KW. horizontal steam turbo-alternator with condensing plant, for the Municipal Council. See "Official Notices" January 26th.

Sheffield.—February 19th. Stores for the Corporation Tramways Department. See "Official Notices" February 2nd.

Stockton-on-Tees.—February 16th. Annual supplies for the electricity department. See "Official Notices" to-day.

Stoke Newington.—February 19th. Sub-station electric lighting and other work for the Council. See "Official Notices" February 9th.

Sunderland.—March 1st. Six vestibule cars, double-deck top-cover type, with approved radial trucks. See "Official Notices" to-day.

Sunderland.—March 2nd. Feed pump, cooling tower, surface condenser, coal bunkers, &c., for the Electricity Department. See "Official Notices" January 26th.

Sydney (N.S.W.).—May 7th. Boilers, stokers, pipework, turbo-alternator, sub-station machinery, switchboards, &c., for the Council. See "Official Notices" February 9th.

Wakefield.—February 17th. Water softening and purification plant for the electricity department. See "Official Notices" February 2nd.

West Ham.—February 16th. One 1,500-2,000-KW. two-phase turbo-generator, one 500-KW. motor-generator, and switchgear for the same, for the Council. See "Official Notices" February 2nd.

West Ham.—March 2nd. Lamps, cable, motors, transformers, meters and cut-out boxes, for the Electricity Department. See "Official Notices" to-day.

West Hartlepool.—February 26th. One 500-KW. high-speed engine and continuous-current dynamo for the Corporation. See "Official Notices" February 9th.

CLOSED.

Bath.—The T.C. has accepted the tender of the National Telephone Co., Ltd., for the installation of electric fire alarms at an annual charge of £106 for seven years.

Birmingham.—The British Thomson-Houston Co., Ltd., have secured a contract from the Corporation for 90 5-ampere fixed frame continuous current series multiple enclosed arc lamps with self-contained substitutional resistance. These are to be connected five in series on the tramway circuit, and are equipped with solid copper casings, single spherical enclosing globes, and 21½ in. diameter metal reflectors.

Clydebank Dock.—The Glasgow Electric Crane and Hoist Co. has secured the order to supply three motor-electric cranes for the new dock, and Messrs. Siemens Bros. & Co. are installing generating plant. Messrs. Stothert & Pitt have fitted up six electric cranes for this dock.

Croydon.—The B.G. has accepted the tender of Messrs. Newbald & Co. for the installation of an electric fire alarm system, at £115 10s.

Dartford.—The U.D.C. has accepted the tender of Messrs. J. G. White & Co., Ltd., for the construction of sumps for draining the tram lines, at £6 17s. 6d. each.

Gravesend.—The T.C. has entered into an arrangement with Mr. Sidney Blandford and Messrs. Hooper, Leavy & Co., for the wiring of private houses for the E.L. on the deferred payment system.

Glasgow.—The Tramways Committee has accepted the following offers:—

Galvanised wire	John Stewart & Co., Ltd. Croggon & Co., Ltd. F. Smith & Co., Ltd.
Enclosed arc lamps	Brockie-Pell Arc Lamp Co.
Wall telephones	Ericsson Bell Co.
Copper bonds	Lahmeyer Electrical Co.
Switches for section pillars ..	Estler Bros.
Gear cases	British Westinghouse Co.

London.—Stepney.—The B.C. has received the following tenders:—

Twenty-Two Edgewise Voltmeters.

Everett, Edgcumbe & Co. ..	(accepted)	£76 5 0
Nalder, Bros. & Thompson, Ltd.		79 15 0
Crompton & Co., Ltd.		81 15 0
Evershed & Vignoles, Ltd.		86 6 8
Kelvin & James White, Ltd.		95 0 0
Elliott Bros.		97 15 0

Supply of Arc Lamp Globes for Two Years.

De Grelle, Houdret & Co. ..	(accepted)	£77 0 0
Carl Quitman		79 16 0
City Glass Co.		84 12 0

Fulham.—The B.C. has accepted the following tenders in connection with the electricity undertaking:—

Edward Le Bas & Co., steam piping	£990 0 0
Clapham Bros., water and exhaust piping	1,284 6 0

Marylebone.—The E.L. Committee has accepted the following tenders for tools for the generating station workshop:—

Messrs. Hobdell, Way & Co.—One 15-in. lathe, £275; one 10-in. lathe, £82; one 6-in. lathe, £35 10s.; one radial drill, £90; one screwing machine, £28 15s.; one emery grinder, £7 10s.; one grindstone, £6 5s.; one bench drill, £4 10s.; motor shafting and belting, £95.

Messrs. Selig, Sonnenthal & Co.—One 24-in. stroke shaping machine, £82 10s.

Messrs. Herbert Morris & Bastert.—One workshop crane and rails and one jib crane, including erection, £89 14s.

Swindon.—The T.C. has accepted the tender of Hadfield's Steel Foundry Co., Ltd., Sheffield, for the supply of a single track tramway lay out, at £112, and that of Messrs. A. & J. Main and Co., Ltd., London, for the erection of a temporary car-shed, at £315.

Torquay.—The T.C. on February 7th accepted the tender of the British Insulated & Helsby Cables, Ltd., for the supply of cable for E.L. extensions, at £237.

Tunbridge Wells.—The T.C. has accepted the tender of the General Electric Co., Ltd., for the supply of motor meters, and has decided to purchase 100 demand indicators from Chesterfield T.C.

West Ham.—The Corporation has accepted the tender of the British Westinghouse Co. to supply eight tramcars on radial trucks, at a price of £546 10s. for the first car and £568 for each of the balance, the Council to have the option of ordering additional cars to the number of seven at the latter price, providing the order is given within 18 months from the time of signing the contract.

Wolverhampton.—The Corporation has accepted the tender of the Electric Construction Co., Ltd., amounting to £250, for three balancing sets.

FORTHCOMING EVENTS.

To-day's Events (Friday, February 16th).—At 8 p.m. I.M.E. Mr. G. J. Churchward on "Large Locomotive Boilers."

At 8.30 p.m. Chemical Society. Meeting.

At 9 p.m. Royal Institution. Mr. W. C. D. Whetham on "The Passage of Electricity through Liquids."

At 5.45 p.m. Northampton Institute Engineering Society. Mr. A. G. Savill on "Secondary Batteries."

At 7.30 p.m. N.E. Coast Institution of Engineers and Shipbuilders. Meeting at Newcastle.

Saturday, February 17th.—At 7.30 p.m. Glasgow Technical College Scientific Society. Mr. G. Inglis on "The Inglis Patent Boiler."

At 7.30 p.m. Birmingham and District Electric Club. Mr. J. G. Moon on "The Production of Gas for Industrial Purposes."

Monday, February 19th.—At 8 p.m. Society of Arts. Cantor Lecture. "Modern Warships." By Sir William White. Lecture IV.

Junior Institution of Engineers. Visit to the Electrical Standards Laboratory of the Board of Trade, Whitehall.

Tuesday, February 20th.—At 8 p.m. Electrical Contractors' Association. Meeting at Frascati's Restaurant. Mr. L. M. Waterhouse on "Conduits."

Thursday, February 22nd.—At 2.30 p.m. I.E.E. (Students). Visit to the Robertson Lamps Works, Hammersmith.

At 8 p.m. I.E.E. Mr. Claude W. Hill on "Crane Motors and Controllers."

Friday, February 23rd.—At 5 p.m. Physical Society Meeting.

At 8 p.m. Electro-Harmonic Society. Ladies' Night. Concert at the Holborn Restaurant.

At 9 p.m. Royal Institution. Prof. J. O. Arnold on "The Internal Architecture of Metals."

Saturday, February 24th.—At 6.45 p.m. I.E.E. (Students). Dinner at Grand Hotel, Manchester.

Association of Engineers-in-Charge. Social Dance.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued:—

Monday, February 19th.—"A" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Tuesday, February 20th.—"B" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.; medical examination recruits, 7 p.m.
Wednesday, February 21st.—"A" badge examination for "A" and "B" Companies.
Thursday, February 22nd.—"C" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Friday, February 23rd.—"D" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Saturday, February 24th.—Week-end instruction for "B" Company (Cambridge detachment).

J. H. S. Phillips, Captain E.E.
For O.C.E.E.R.E. (V.).

NOTICE.

If any of our readers should find it difficult to obtain the Electrical Review at railway bookstalls, or otherwise, the publishers will esteem it a favour if they will communicate the fact direct to them at the Electrical Review Office, 4, Ludgate Hill, London.

NOTES.

Institution Notes.—Iron and Steel Institute.—The annual general meeting will be held at the Institution of Civil Engineers on Thursday and Friday, May 10th and 11th. The Council will shortly proceed to award Carnegie Research Scholarships, and candidates must apply before February 28th. The awards will be announced at the general meeting. In place of the ordinary autumn meeting, a joint meeting of the American Institute of Mining Engineers and of the Iron and Steel Institute will be held in London on July 23rd—29th. The Lord Mayor of London will act as chairman of the London Reception Committee, and will give a conversazione at the Mansion House on the evening of July 27th. The annual dinner will be held in the Grand Hall of the Hotel Cecil on Friday, July 27th. A programme of the visits and excursions to be made during the meeting will be issued when the arrangements are sufficiently matured. Members of the Institute are invited to take part in the Sixth International Congress of Applied Chemistry, to be held in Rome from April 25th to May 3rd. One of the sections of the Congress is devoted to metallurgy, and among the excursions will be one to the ironworks of the Island of Elba.

I.E.E., Dublin.—A meeting of this section was held on 8th inst., in the College of Science, Dublin, Mr. P. S. Sheardown presiding. Mr. W. J. Belsey read a paper entitled "Some Notes on Motor Driving," in which he gave some very interesting details anent the various types of motor suited to the various machines used in the industries of this country.

Tramways and Light Railways Association.—The *Official Circular* for February contains the paper on "Brakes," by Mr. A. L. C. Fell, which was read before the Association on January 10th; also the discussion which followed, and Mr. Fell's reply, which has been subsequently communicated.

Junior Institution of Engineers.—The annual dinner took place on Saturday last. Our report is unavoidably held over.

The New Magnetic Observatory.—The *Standard* says that work is being pushed on energetically in connection with the erection of the new Magnetic Observatory at Eskdalemuir, Dumfriesshire, which is to take the place of the existing one at Kew, the site of the latter having become unsuitable, owing to neighbouring electric installations and railways. A water supply has already been introduced, a new road made, and the foundations of the buildings constructed.

Electric 'Buses.—It is reported that a service of electric omnibuses has been inaugurated on Fifth Avenue, New York. The vehicles weigh 7 tons each, and are driven by electric motors, which are fed from a dynamo driven by a 30-H.P. petrol engine. A small storage battery is provided for starting and lighting. The 'bus carries up to 50 passengers, and runs at 15 m.p.h.

Annual Dinner.—The first annual dinner of the members of the electrical departments attached to His Majesty's Theatre was held on Sunday evening, February 4th, at the Horse Shoe Hotel, Tottenham Court Road. The employés and guests present numbered nearly 60, under the presidency of Mr. Cecil King, the stage manager. Mr. Beerbohm Tree sent on some cigars, "so that the lights may not be out."

Electrical Volunteers.—The fourth annual dinner of the Chelmsford detachment of the Electrical Engineers (Volunteers) was held at the White Hart Hotel, Chelmsford, on February 3rd, the company numbering about 50. Sergeant Deverill presided, supported by Lieutenant Sheppard, Captain Fred Taylor (2nd V.B.E.R.), Comp.-Sergt.-Major Cooper, and Sergt. Riley.

Halifax Technical Schools.—The Halifax Education Committee has decided to enlarge the equipment of the Electrical Engineering Laboratory at the Technical Schools, at a cost of £730.

Municipal Accounts.—The London Chamber of Commerce Municipal Trading Committee has made arrangements for a conference of Chambers of Commerce, local authorities and industrial associations on March 5th regarding the audit of municipal accounts. The Chamber passed the following resolution:—"This Council, while of opinion that the Departmental Committee appointed to inquire into the standardisation of the accounts of municipal and other local bodies would have commanded in a greater degree the confidence of the commercial community if a larger number of independent professional auditors had been recommended to act upon it, welcomes its appointment as a step in the right direction, and hopes that its report will be issued before the close of the present Parliamentary session, in order that effect may promptly be given to its deliberations."

A Novel Resistance Material.—In a recent issue of *L'Industrie Electrique*, an account is given of the use of magnetite, or a mixture of this with chromate of iron, as a resistance material, under a patent taken out by Mr. C. P. Steinmetz. The substances named are chemically stable and of solid structure, even at a red heat, when the resistivity of magnetite, which has a negative temperature resistance coefficient, is only one-hundredth of its value cold. It is proposed to use these materials as automatic starting resistances for electric motors. In the case of an induction motor, for example, magnetite resistances are inserted in the three-phase winding of the rotor; at starting the resistances are high, giving a high torque, but when running, as the resistance material grows hot, its resistance falls, automatically short-circuiting the winding and giving high efficiency. We cannot agree with our contemporary, however, that such means are suitable for crane and capstan motors, &c., which are liable to frequent starts, for obviously the hot magnetite will take some time to cool, and if the motor be started again before this operation is completed, the resistance will be absent. There are, no doubt, many cases in which this objection will not hold good.

Tramway Criticism.—In a recent issue of the *Surveyor* an abstract is given of an address delivered by Mr. Jas. Dalrymple, general manager of the Glasgow Corporation Tramways. Referring to the cable system in Edinburgh, Mr. Dalrymple thought the less said about that the better. London had the conduit system as worked by the London County Council. It was a most extravagant system, which should never have been called into requisition, but in London they could do things which nobody else could do. London had a traffic which no other city had, and they were entitled to do something different from what was done elsewhere. Proceeding to deal with American cities, he referred to the great amount of traffic on Brooklyn Bridge; the great delays which were experienced there at, say, five o'clock in the evening, were things which the people in this country would not stand at all, but which the American people seemed to enjoy. When he first landed in New York in May last he thought he had never seen anything so fearful as the dirty cars and the condition of the streets there, though he saw something worse afterwards. The elevated and street cars in the city of Boston were the finest in America, well managed and beautifully equipped. When he reached Chicago he thought the streets were the worst that could be conceived. They seemed to spend no money on their streets, and, in fact, the municipality had no more money to spend now than when Chicago was a fourth or fifth rate city. The Chicago tramway system was the worst in this world. The reason was that the municipality and the tramway companies had been disputing for years over various points, with the result that nothing was done to keep up the system. Altogether the system was very, very far down, and the people of Chicago had good cause to say they must have a change, and that the cars should be worked as a municipal department. He had told the people over there that he believed they had the making of the finest and biggest tramway system in the world. The streets were for miles and miles as level as an ordinary floor, and there was nothing to hinder an enormous business being done. He thought if Mayor Dunne took the advice that had been offered him he would get municipalisation in the proper way, and better than if he had followed the course he had set out for.

Appointments Vacant.—Assistant mechanical and electrical engineer for the Cornwall County Asylum at Bodmin; two additional assistants are required for the Central Technical College, Exhibition Road, electrical engineering department, at £300 and £150 respectively; meter inspector for the Barnsley Corporation (30s.); junior shift engineer for Dover (£70); works superintendent for York Electricity Committee (£150).

Dartford Tramways Opening.—The system of electric light railways, some 6½ miles long, which connects Bexley Heath with Dartford and Horn's Cross (about 1½ miles from the terminus of the Gravesend and Northfleet Tramways) was opened on Wednesday last. Following a tour of the routes, the invited guests were entertained at luncheon, at the Bull Hotel, Dartford, when the usual loyal and congratulatory toasts were proposed. The population of the districts served, not including Erith and Bexley,

is some 30,000. Messrs. J. G. White & Co. were the contractors for the work, and are the lessees of the undertaking; Messrs. Hawtayne & Zeden acted as the Council's consulting engineers.

Electro-Harmonic Concert.—Friday next, February 23rd, will be a Ladies' Night at the Electro-Harmonic. The programme includes:—Vocal music by Miss Edith Serpell, Miss Florence Venning and Mr. Gregory Hast; violoncello solos by Mr. B. Walton O'Donnell; also miscellaneous items by the following artistes:—Mr. Walter Graham (the Human Marionette); Miss Elsie Walker (recitations with music); Mr. Wilson James (humorous songs); and Mr. Astley Weaver (humorous sketch).

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*]

Central Station Engineers.—We understand that Mr. J. H. Fooks Bale has resigned the position of electrical engineer and tramways manager to the Walthamstow Urban District Council.

In our last issue, Mr. F. W. Hewitt, Darlington, was described as a shift engineer. This was incorrect. He holds the position of chief assistant in the electricity and tramways departments.

The Middlesbrough Electric Lighting Committee last week decided to grant the electrical engineer (Mr. Taylor) an honorarium of £50, and to increase his salary from £400 to £450 per annum, subject to the Council's confirmation.

On February 12th, at Holly Hall Church, Dudley, Mr. Frederick A. Watkins, assistant engineer to the Borough of Hornsey electricity works, was married to Lilian B. Stevens, third daughter of T. Stevens, Esq., of Holly Hall.

The Bristol Council on Tuesday considered a proposal from the Electricity Committee to increase the salary of their electrical engineer, Mr. Faraday Proctor, from £700 to £800. In addition to his salary, Mr. Proctor has £100 a year from improvers' premiums. Warm appreciation was expressed for the electrical engineer's services, but the increase was objected to by many members, and defeated by 31 to 27 votes. The salary of Mr. H. H. Couzens, the deputy electrical engineer, was increased from £350 to £375 as from January 1st, 1906, and £400 from January 1st, 1907.

Mr. D. H. Simpson, assistant borough electrical engineer, has declined to reconsider his resignation as the Bridlington Council asked him to do when it offered to grant him the advance of salary, which it had before refused to grant although the Committee recommended it.

The Canterbury T.C. has increased the salary of Mr. Challis, shift engineer, to £62 per annum. A recommendation to increase the salary of Mr. Blascheck, resident electrical engineer, by £25 per annum has been rejected by the Council.

The St. Helens T.C. has appointed Mr. Sedgwick as shift engineer at the electricity works. There were 170 applicants.

Mr. R. L. Acland, the borough electrical engineer and tramways manager, of Chesterfield, has been given an honorarium of £400 for extra work when acting as consulting engineer for the tramway scheme recently brought into operation.

Tramway Officials.—Mr. R. E. Hunt has been appointed assistant manager of the Buenos Aires and Belgrano Tramways Co.

The *Review of the River Plate* says that Mr. H. C. Bocquet, general manager of La Capital, Grand National and Metropolitan Electric Tramway Companies, left Buenos Ayres on the 29th ult. for England, to take a short holiday. The electrification of the Grand National is to be pushed ahead, so as to be completed within two years.

Mr. Stephen Billington, of Salford, has been appointed, out of 40 applicants, as tramways accountant on the City of Gloucester Light Railways.

Inspector Hyett, of the Corporation Tramways, Swindon, was the recipient, last week end, of a marble clock, subscribed for by the staff. In making the presentation, the traffic manager (Mr. T. Medcalf) spoke very highly of Inspector Hyett's good work at Swindon, and wished him every success in his new appointment of chief inspector to the Dartford Light Railways.

On the 10th inst. the employés of the Wakefield and District Light Railway Co. presented Mr. Chas. Carley, inspector, with a marble timepiece, on the occasion of his marriage. Motorman Chas. Edwards made the presentation on behalf of the staff. A smoking concert followed.

General.—Mr. Reginald G. Tolley, late of Messrs. Johnson & Phillips, Ltd., has been appointed assistant engineer on the electrical staff of Messrs. Vickers, Sons & Maxim's Steel Works, Sheffield.

Mr. W. W. Lackie, chief electrical engineer to the Glasgow Corporation, and Prof. Magnus MacLean, Glasgow, have been elected members of the Institution of Civil Engineers.

Mr. C. C. F. Moncketon, M.I.E.E., consulting electrical engineer, has removed to Parliament Mansions, Victoria Street, Westminster, S.W.

CITY NOTES.

"No Admission."

The Electric Light & Traction Co. of Australia, Ltd., appears not to desire publicity. From the company's birth until this week we have been admitted to its meetings without any question, but when we presented ourselves at the office on the fifth floor at Finsbury Pavement House on Monday last, we were refused admission on the grounds that there was "not room" for us. Then why not hold the meeting where there would be room, and enable us to inform our readers in this country and in Australia of what transpires? In its early struggles with adversity the company saw the wisdom of having full, free, and independent publicity. Now that it appears to be turning the corner a drastic policy of retrenchment seems to have been adopted, and the guinea or two spent upon a basement room at Winchester House is found to be too heavy a burden! The directors' report appeared in our last issue, but whatever Mr. Braithwaite may have said on Monday cannot be reported here because the room was too small to contain us. Is there another public electrical company of standing in London that refuses the Press admission to its annual meeting? We say no more save that the step does not inspire confidence.

Bristol Tramways and Carriage Co.

The directors' report says that the gross receipts for the year ending December 31st, 1905, amounted to £256,742, and the working and general expenses and renewals to £171,661, leaving a net revenue of £85,080. The following amounts have already been distributed, viz.:—Interest on 4 per cent. mortgage debenture stock, and deposits, £11,277; dividend on 4 per cent. preference shares, £19,000; interim dividend at the rate of 8½ per cent. per annum (subject to income-tax), for the half-year ending June 30th, £20,187 = £50,464. It is proposed to appropriate as follows:—Final dividend for half-year at the rate of 9½ per cent. per annum (subject to income-tax), £22,563; addition to reserve for contingencies fund, £12,053, = £34,616; net revenue = £85,080.

The interest on investments has been carried to the credit of contingencies fund, and the values of the investments having been adjusted to market prices at December 31st last, the reserve fund then totalled £161,405. The company's investments have thus been increased by £25,508 during the past year, and with the addition now proposed will be further augmented to £173,459. The total number of passengers carried during the year on the company's cars and omnibuses was 45,294,177. Since the close of the year under review, the directors have arranged for the introduction of services of motor-omnibuses in conjunction with and as feeders to the electric tramways. The operation of permanent routes to Clifton, Westbury-on-Trym, Thornbury, Kelston and Saltford, has already been commenced, and further similar services for the accommodation of other districts in and around Bristol are in course of preparation.

National Electric Supply Co.—The meeting was held at Preston on February 8th. Dividends of 4½ per cent. on the preference, and 4s. on the ordinary (making 7s. per share for the year), were declared. The latter represents a slight decrease which has been made in order that the amount to reserve for depreciation and for carrying forward might be increased. The 1904 dividend was 8s.

South Wales Electrical Power Distribution Co.—At a special meeting held on the 7th inst., the Bill for raising additional capital was approved.

Oxford Electric Co.—Subject to final audit, the directors have recommended a dividend of 7 per cent. for the year ending December 31st, 1905, free of income-tax, including the interim dividend of 2½ per cent. paid in September last. Last year the dividend was at the same rate.

Notting Hill Electric Lighting Co.—The gross revenue for the year was £35,315, an increase of £750, and the total net profit was £19,984. £3,000 is placed to depreciation, renewal and reserve, £5,425 is required for debenture interest, and the usual dividend of 6 per cent. is paid on the preference and ordinary shares. A further 1½ per cent. is to be paid on both ordinary and preference, and £3 per share on the founders' shares. The distribution last year was altogether 7 per cent. on the ordinary.

Metropolitan District Railway Co.

The report up to December 31st, 1905, shows total receipts for the half-year £203,509, an increase of £6,092. Working expenses have been £144,076, an increase of £29,863. The revenue account shows a profit of £59,433, a decrease of £23,771. The total number of passengers carried during the half-year has been 2,220,631 in excess of the corresponding period of 1904. The abolition of second-class bookings has, however, involved the transference of a very large number of passengers from second to third class; and this fact, coupled with the partial suspension of season-ticket bookings, has caused a serious loss of revenue. Electric traction was partially commenced on July 1st last, but the entire substitution of electricity for steam was not completed until the month of December. The unavoidable continuance of steam working concurrently with electric traction not only involved special expenditure, but also delayed the completion of the automatic signal installation, dislocated the train services and prevented the running of a sufficient number of trains during the rush hours to provide for any substantial increase of traffic. These exceptional and

adverse conditions of working during the half-year prevented the company from realising to any material extent the advantages to be expected from the adoption of electric traction. The amount necessary to meet the company's fixed charges (including interest upon an additional sum of £300,000 debenture stock, as compared with the corresponding half of last year), and to pay to the 4 per cent. guaranteed stockholders a dividend at the rate of £1 2s. 6d. per cent. per annum, is insufficient by £26,613. The directors are advised that the company has power to charge this deficiency to capital account. The total cost of the electrical equipment and installation, including 434 cars, was, up to December 31st last, £1,677,000, exclusive of discount on stock issued in payment thereof. It is estimated that subsequent outlay, including 70 additional cars, will be £235,000. Power is being taken in the company's Bill now before Parliament to provide the necessary capital for this purpose. The account of the Metropolitan and Metropolitan District City lines and extensions show net revenue £9,225, a decrease of £1,685.

London Electric Supply Corporation.

THE directors' report for the year ended December 31st, 1905, shows that the profit on the working for the year is £78,721, to which has to be added interest on deposit and the amount brought forward, £2,614, less expenses incurred in Parliament last session, viz., £1,946, making a total of £79,390. Out of this the interest on debenture stock to December 31st, viz., £14,976, has been paid, leaving a balance of £64,414. The board propose to deal with this amount as follows:—

Dividend of 6 per cent. on the preference shares, for the year (of which an interim dividend of 3 per cent. was paid on September 1st, 1905), viz.	£17,952
Dividend of 4 per cent. on the ordinary shares for the year ..	13,320
To reserve account (making a total of £50,000)	25,000
To provision for contingencies (making a total of £10,000) ..	5,000
To carry forward	3,142
	£64,414

The supply of energy for power and lighting has been efficiently maintained during the year, and the decrease in the cost of production (viz., over 20 per cent.) has more than fulfilled anticipations. The number of units sold during the year amounted to 13,042,932, as compared with 10,531,785 during 1904. The capital expenditure for the year was £42,042, and was principally in connection with the two new low-tension stations erected in Southwark and Deptford, and the mains thereof. The plant and machinery have been maintained out of revenue, and, as will be seen from the engineers' report, are in efficient condition. The directors have entered into a further agreement with the London County Council, for a period of three years, for supplying power to the Council's tramways at the expiration of the existing agreement. Other negotiations are in progress for large power contracts. The directors have deposited a Bill in the ensuing session of Parliament for conferring further powers upon the company; and, at the conclusion of the general business, a special meeting will be held for the purpose of confirming the special resolution in respect thereto, passed unanimously at an extraordinary general meeting, held on the 1st inst. Several Bills have been deposited affecting the company, which are receiving the careful consideration of the directors.

[The ordinary dividend for 1904 was at 3 per cent.]

Charing Cross, West End and City Electricity Supply Co.

THE directors' report for the year ended December 31st, 1905, says that there has been a large increase in the demand for energy for motive power and heating, and, in addition, the demand for lighting has been well maintained.

West End Undertakings.—The company has now connected to its mains a total equivalent of 453,285 8-C.P. lamps, which is an increase of 43,622 upon last year's figures. The total includes 349,530 in lighting and heating apparatus, and 103,655 (4,146 H.P.) in motors. The total mileage of mains now laid amounts to 347. The directors, some time since, decided to convert the steam generating station at Maiden Lane into a motor-generator and battery station, and the necessary reconstruction of the buildings has been completed. This has involved the sale of the old plant, but the result is to double the capacity of the buildings. The difference between the cost and selling prices of the old plant has been written off, through depreciation account. The revenue from sales of current for 1905 amounted to £127,787, as against £122,878 last year. The balance of the net revenue account is £47,687, which it is proposed to deal with as follows:—Dividend on the 4½ per cent. preference shares, absorbing £18,000; dividend on the ordinary shares at the rate of £5 per cent. for the year 1905, requiring £20,000; carrying forward £9,687.

City Undertaking.—The front portion of the site at Fenchurch Street has been let on a building lease to substantial tenants. The company has now connected to its City mains the total equivalent of 371,209 8-C.P. lamps, which is an increase of 70,128 upon last year's figures. The total includes 274,509 in lighting and heating apparatus and 96,700 (3,868 H.P.) in motors. The total mileage of mains now laid, amounts to 286. The gross revenue from sales of current during the year 1905 amounted to £92,210, or £13,779 in excess of 1904. The balance of the net revenue account shows a profit of £8,353, which has been applied towards payment of the £18,000 required for dividend on the preference shares, leaving £9,647, which has been advanced by the West End undertaking under its guarantee. The 5 per cent. City undertaking debenture bonds will mature on July 15th, 1906, at par.

The engineer-in-chief certifies that the plant and machinery have been maintained in a high state of efficiency.

An Exhibition of a permanent character, designed to illustrate the various commercial and domestic uses to which electrical energy can be applied, has been opened at the company's sub-station, 85, Fenchurch Street; by arrangement with manufacturers and others, it has been equipped with machinery, apparatus and fittings of the latest type and suitable for power, heating, lighting and hygienic purposes. The Exhibition has excited wide-spread interest, and it is hoped that it will conduce to the extension of the company's business.

The Bill promoted by the company in the last session of Parliament for further powers to enable it to supply electric energy for railways, tramways and power, over a large area, did not pass. The directors have thought it advisable to re-introduce a Bill for these purposes this session.

The meeting is to be held on Monday, 19th inst., at the offices.

STATEMENT OF ELECTRICITY GENERATED, SOLD, &C., IN 1905.

	City undertaking.	West End undertakings.
Quantity generated in B.O.T. units	12,174,104	10,633,778
Quantity bought in B.O.T. units	854,674	3,396,337
Quantity sold—Public lamps	—	461,549
Other sales	9,757,600	9,515,049
Total sold	9,757,600	9,976,598
Quantity used on works..	2,934,393	3,660,034
Total quantity accounted for	12,691,993	13,636,632
Quantity not accounted for	336,785	393,483
Number of public lamps	—	179
Total maximum supply demanded in KW. ..	8,977	5,245

W. H. PATCHELL, *Engineer-in-Chief.*

National Telephone Co.

THE report of the directors for the half-year ending December 31st, 1905, says that the income accrued in respect of the business of the half-year amounts to £1,125,978, as compared with £1,033,706 for the corresponding period of 1904, being an increase of £92,272. The working expenses for the half-year amount to £647,847, as compared with £591,636 for the corresponding period of 1904, being an increase of £56,211. The net result for the half-year (after deducting the Post Office royalties, amounting to £105,866), is a profit balance of £372,265, as compared with £346,875 for the corresponding period of 1904, being an increase of £25,390. The rentals carried forward for unexpired terms of running contracts amount to £972,500, as compared with £889,578 at the corresponding period of 1904, being an increase of £82,922. Out of the available balance of £285,109 shown by the net revenue account, the board will recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock and 5 per cent. per annum on the deferred stock, less income-tax in all cases. The board also propose to transfer £125,000 to the reserve fund, and to carry forward the balance of £9,859. The sum of £497,962 3s. 7d. has been expended on capital account during the half-year in the erection of 24,179 additional exchange and private stations and in the construction of underground works. The board anticipate that there will be considerable development in the business of the company during the next few years, and proposals will, therefore, be submitted to the shareholders for an increase in the company's capital. In their report for the half-year ending December 31st, 1904, the directors stated that—

The board after protracted negotiations have arrived at an agreement with the Postmaster-General for the sale to him on December 31st, 1911, of the undertaking of the company, which agreement is subject to the approval of Parliament.

During the last session of Parliament this agreement was considered by a Select Committee of the House of Commons, who reported in favour of the agreement with modifications, some of which the board accepted. With regard to one important recommendation of the Select Committee relating to the position of the company's employés upon the transfer of the undertaking after December 31st, 1911, the Postmaster-General in the House of Commons on behalf of the Government made the following statement:—

The Postmaster-General will take into the service of the Post Office the servants and officers of the company who have been not less than two years continuously in the service of the company on December 31st, 1911, and such officers and servants shall enjoy the advantages and be subject to all the conditions of the rank or grade to which they are admitted in the same manner as other officers and servants of the Post Office in that rank or grade. This undertaking does not apply to the general manager or to officers of the company in receipt of £700 per annum or upwards.

The agreement came into force on August 31st, 1905. It is a matter of satisfaction to the board that as the outcome of the consideration of the agreement by the Select Committee and by the action of the Postmaster-General a reasonable arrangement has now been made with respect to the great bulk of the officers of the company, for which the board have throughout the negotiations earnestly striven. As regards the limited number of the staff to whom the Postmaster-General's undertaking does not apply, and others not coming within such undertaking, the board propose forthwith to establish a fund from the revenues of the company applicable, in their discretion, to compensation in these cases.

Liverpool Overhead Railway Co.

THE half-yearly meeting was held on February 13th at Liverpool. Sir WM. FORWOOD, who presided, in moving the adoption of the report, regretted that it was not of a more satisfactory nature. The present accounts referred to a period during which the railway had encountered a new and serious competition from the electrical service inaugurated by the Lancashire and Yorkshire Railway on the Liverpool and Southport line. They also marked a period of transition from a uniform charge to all their stations to a differential system of fares; and whilst they had suffered severely from this new

competition, they had not yet had time to reap the benefit whic they hoped would come to them from the alteration in their fares. Also they had not so far had the full advantage of their connection with the Seaforth Station of the Lancashire and Yorkshire Railway, which was opened in July last. Referring to the traffic, he said they had, in the aggregate, carried more passengers during the past six months—5,617,632, against 5,613,752—but they had lost both in first and third-class traffic, and the gain had been entirely in workmen's special return tickets. He thought these figures proved that, while, by adopting a lower fare for their working-man traffic, they had succeeded in increasing that traffic. On the other hand, many of their third-class passengers now availed themselves of the cheap workmen's tickets. Their gross earnings were £39,388 against £41,487 during the corresponding half of last year. The principal loss of earnings had been sustained in the Seaforth section of the line. The tramway receipts had fallen off £547, and the takings at Seaforth Sands had decreased by £1,003. These two items alone accounted for £1,550 of the decrease, which was obviously traceable to the new competition of the Lancashire and Yorkshire Railway. The average receipts per passenger worked out at 1·78d., as compared with 1·83d. on the City and South London Railway, 1·83d. on the Central London, and 1·79d. on the Mersey Tunnel Railway. This comparison was not altogether unfavourable, but they must take into consideration with it the amount earned per train-mile. While their earnings had only been 20·91d., those on the City and South London had been 30·79d., the Central London 66·80d., and the Mersey Railway 25·35d. The expenditure had gone up from £29,550 to £30,686, an increase of £1,136, which was mainly due to the differential system of fares necessitating tickets and ticket collectors. The expediture per train-mile worked out at 17·32d. Local rates bore heavily upon them, and it was a cruel injustice that they had to pay them, whilst the Corporation tramways paid nothing. The renewals fund now amounted to £31,753, and as they maintained their line in a very efficient state out of revenue, they thought the £1,500 now put aside was ample. They had the sum of £11,788 to deal with in the profit and loss account, of which debenture interest absorbed £4,171, leaving £7,460 available for dividend. They proposed to pay 5 per.cent. on the preference shares, and to carry the balance of £3,784 forward. Being determined to leave no stone unturned to find out if any screw were loose, they had engaged Mr. Jenkins, the general manager of the City and South London Railway, to examine the line to make a report. He had made several important suggestions, which were now engaging the attention of the board, but in reference to their expenditure he said:—"I think, on the whole, the traffic department is well and economically worked, and that the staff in that department is at its minimum, consistent with efficiency, but could control a much larger traffic—that is to say, given an increased revenue, the ratio of expense would immediately come down." He (the chairman) did not think they could hope for any decrease in their expenditure. They had a structure which must be carefully kept up, and they were working a rapid and frequent service. The equipment and rolling stock must be maintained in an efficient condition, and he was glad to say that Mr. Jenkins stated in his report, "Judging from my own observations the rolling stock and generating plant are kept in a high state of efficiency." It was something to have run over 1,000,000 train-miles during the year without an accident. This was a record of efficiency, which could only be maintained by constant supervision and care. Mr. Jenkins suggested the closing of four of the smaller stations, and this was now engaging the consideration of the board. They had been strongly urged by shareholders to adjust their fares more on the basis of the tramway charges, but the fares were now as low as they could afford. In looking to the future, he thought there were certain facts which might afford them some encouragement. The past half-year had been full of difficulties which had not made for the company's prosperity. These included the novelty of the new electrical service on the Southport line, but he thought that competition would diminish in the future. The delay in opening up their through service to Southport had also injuriously affected them, as they had had to pay all the costs of the capital employed, with no adequate return. He gave a brief survey of the company's history to show that there was a considerable growth and elasticity in their traffic, and that notwithstanding present disappointment there was a future for the railway. The directors were not discouraged. They intended to continue the fight, and it would not be for want of thought, work, or skill if they failed to recover the prosperity which, for a time, had been taken from them.

Mr. Richard Hobson seconded the motion.

The Chairman, replying to questions, said an opinion had been expressed that a traffic manager with a general knowledge of railways would be of more value to the company than a professional engineer, such as Mr. Cottrell, the present engineer and manager. But they required for the Overhead Railway—which, to a certain extent, was novel—very careful and scientific supervision, such as Mr. Cottrell was able to exercise. The directors set a very high value on Mr. Cottrell's administrative ability. They paid him £1,200 a year, and he (the chairman) did not think it would be possible for them to get an efficient and capable man for very much less salary than that. Apart from the unfortunate fire at the Dingle, they had never during their 13 years' existence had a serious accident on their line, and whenever there had been a minor mishap Mr. Cottrell and his staff had always been on the spot a few minutes after the event, and had restored the line to working order after a very short interval.

The report was then adopted, and the preference dividend passed, after which Mr. R. Hobson and Mr. H. C. Woodward were re-elected directors.

St. James' and Pall Mall Electric Light Co.

The ordinary general meeting was held on Tuesday, at Carnaby Street, Mr. W. Leaf, the vice-chairman, presiding.

The Chairman, in proposing the adoption of the report, said he wished to explain why it was that the directors were not able this year to pay the usual bonus in addition to the dividend. It would be within their knowledge that the past year had been one of exceptional difficulty, anxiety and labour for all connected with electrical industries. As the directors had long foreseen, the question of the bulk supply of electrical energy for London had now become acute. They would recollect that when they formed the Central Co. some years ago it was with the idea of offering such a supply to the West End. Parliament, however, decided to confine the Central Co. to the supply of this company and the Westminster Electric Supply Corporation. Some 15 months ago it was decided that the time had come when they might apply a second time for the larger powers originally asked for, and the Central Co. accordingly promoted a Bill for the purpose. They were, however, met by a formidable opposition in the shape of the very ambitious scheme of the Administrative County of London Co., with the result, unfortunately, that so much of the Central scheme as related to the bulk supply in the West End was defeated in Parliament, though certain useful extensions of power were accorded them. The directors felt bound to oppose by every means in their power the Bill of the Administrative County Co., and succeeded in securing in the last stages of the Bill important concessions which would, in their opinion, have effectually safeguarded the interests of the company. Although the Bill was lost for want of Parliamentary time, the safeguarding clauses which they obtained would be a valuable basis on which to work in the next session, and they must not regard the money spent in opposition as thrown away. The costs, however, had been large, and had been an appreciable factor in the diminution of profits. In the next session of Parliament they had again to face an even more formidable opposition. They had decided to limit their own action to promoting a Bill under the title of the West London Electric Undertakers' Association, to enable themselves and their neighbours, the Westminster Electric Supply Corporation, the Kensington and Knightsbridge, and the Notting Hill Companies, to link up their respective districts for the purposes of a bulk supply. They did not anticipate that that would meet with any serious opposition, as it was entirely unaggressive, and in the public interests. Among the other schemes they would have to deal with were not only those of the Administrative County Bill, who still sought powers in their area, but what was known as the Additional Power Supply Co., and also a Bill of the L.C.C., which recent political events had now brought into the front place. On that, all he could say at present was that the shareholders might rely upon the directors using their utmost endeavours to protect them against unfair competition from municipal enterprise. The serious falling off in their revenue was due primarily to three causes—the first being the cost of Parliamentary proceedings. The next was a reduction of rates, brought about by severe competition. To some extent that had been caused by statements made in Parliament and Press in connection with bulk power schemes, which imperfectly understood had, it would appear, tended to misapprehension on the part of the public as to the price at which electricity could be supplied to the consumer without loss. Competition by gas, too, had been most energetically pushed, and they had felt bound to meet it by corresponding efforts on their own part. The directors were convinced that for power purposes electricity furnished at once the cheapest and most adaptable form of energy, and they had, therefore, decided to offer to consumers a flat rate of 1d. per unit for power and heating from the beginning of the year; and although that must at first leave but a narrow margin of profit, they had every reason to expect that it would materially strengthen their position by an increase in the output, and a consequent reduction in cost, which would ultimately lead to a growth in the revenue. The third cause of their decreased profits was one which was more or less peculiar to that company, and was, happily, of a temporary nature—the demolition of large buildings with a view to re-construction. He might say that, although the ordinary increase in new connections for the past year had been quite satisfactory, the result was that they were only able to show an increase of about 7,000 8-c.p. lamps. As to the future, they had prospects of a continuous growth in the business, they were fully prepared in the equipment of their stations, as in all other respects, to deal with that growth, and they looked forward with confidence to the future.

Sir J. H. Morris seconded the motion, and the report was adopted.

Waterloo and City Railway Co.

Sir Charles Scotter presided at the meeting held at Waterloo Station on Tuesday. He said the report showed that there had been about 50,000 fewer passengers carried, but against that there had been more season tickets issued, and if they took into account the number of journeys made by holders of these they would reduce the decrease by about 25,000; they must also make allowance for two less working days in the half year as compared to the corresponding period, and as they carried about 10,000 to 12,000 passengers per day there was at once an explanation of the apparent decrease in the number of passengers. All conditions being the same the passengers carried were practically the same. The net revenue was £120 less and the working expenses were slightly lower. Failures in working had been fewer than in any

previous half-year since the line had been opened. During the whole of 1905 only 37 very slight cases of delay took place, the greatest being a delay of six minutes which occurred to one train only. In December last through the unfortunate accident at Charing Cross there was very heavy traffic over the Waterloo and City Railway by the South-Eastern season ticket holders, who were allowed to use the line to the city. Some time ago he mentioned that they had been trying to arrange with the South-Western Railway to utilise the surplus power that they had. They had since carried that out, and the Waterloo and City was supplying the lighting of Waterloo Station above-ground at a slight profit. When more current was used of course the profit would be greater.

The report and accounts were then adopted, and the dividend approved.

A Wharncliffe meeting followed, at which the Bill promoted by the company for, among other purposes, conferring powers to amalgamate the Waterloo and City Railway with the L. & S.W. Railway was approved. In referring to the proposal,

Sir Charles Scotter said that the S.W. Railway were seeking purchase powers, but the question of terms had not been settled or mentioned. He proposed that about six or eight of the largest shareholders should meet the directors and discuss the terms upon which the property could be transferred. Shareholders might like to know why, at this particular moment, they entertained the idea of purchase. It had been mentioned that the time was coming when the South-Western should take over the railway, but what had occurred to them as South-Western directors was this, that things were changing with regard to suburban traffic at a rather rapid rate—there were motor-omnibuses, electrification of District Railway, talk of zone fares and low fares and all that sort of thing, and it might happen that the S.W. Co. in its own interests should some day find it necessary to compete, say, with the District or any other railway. They might think a considerable reduction in fares would be necessary, and concurrently with that there would have to be a reduction on the Waterloo and City. The Waterloo and City could not stand any reduction; although the traffic on it was considerable for a little railway, it did not grow at that rapid rate that they thought it would. If the railway had to reduce its fares a serious state of affairs might occur. Although 3 per cent. was secured to the shareholders, there was little possibility or probability of it ever exceeding that amount. The S.W. directors thought the time had arrived when they might fairly take over the railway on terms to be agreed upon. They were not going to arbitration terms. They were either going to agree or not to agree. It would not be policy to discuss terms at that meeting.

Mr. Seaton said he presumed that the arrangement settled between the six or eight shareholders and the directors would only be provisional, subject to approval of terms by the meeting of that company.

The Chairman replied that that was so, and the approval to the Bill was unanimously voted.

Great Northern and City Railway Co.

The fifteenth half-yearly meeting of the shareholders of this company was held on the 8th inst. at Westminster Palace Hotel, the Earl of Lauderdale presiding.

The Chairman, in proposing the adoption of the report, said that the number of passengers carried during the half-year had amounted to 7,383,383, against 5,929,641 for the corresponding period of 1904, giving an increase of 1,453,742, or 24·5 per cent., which was both encouraging and satisfactory. There had been an average increase of 8,000 passengers per day throughout the whole of the six months. At the commencement of the half-year it was 12,000 per day, and at the end 6,000. Comparing the number of passengers carried last half-year with the half-year immediately preceding it, when they carried 7,527,634, it would appear to be somewhat discouraging at first sight. It was really not so, however, because it must be borne in mind that in the second half of the year they had the summer and the holiday months to contend with. The traffic from the commencement of July dropped steadily week by week until the middle of August, since when it had risen continuously until the close of the year, and was still rising. Taking January, 1904, in that month they carried 1,122,672 passengers; this January they had carried 1,219,843, an increase of 97,171, equal to a percentage of 8·66. They had running 11 trains of five cars each during the busy part of the morning at intervals of 2½ minutes. During the afternoon they used two or three-car trains, and again in the evening they reverted to the five-car trains, and on special occasions these were increased to 7. It was intended to shorten the interval between the trains from 2½ minutes to 2 minutes in the morning and evening when the additional rolling-stock had come into full operation. Three new cars had been delivered in the half-year out of 18 which had been ordered. Since the commencement of the year three more had been received, and it was fully expected that they would get the balance before the end of this month. Those cars were fireproof, and were practically made entirely of steel, aluminium, or metal. They were very handsome, and weighed much less than the ordinary cars, and they were not provided with hand straps. The car and train mileage had remained nearly stationary during the half-year. With the exception of a few delays to individual trains there had been no interruption of the traffic, and the ventilation of the tunnels continued to be satisfactory. The power house had also worked satisfactorily, and the consumption of coal continued to show an improvement. For the corresponding period of 1904, the coal consumption was 4,901 tons, in the next half-year it was 4,806 tons, and for the last half-year 4,782 tons, showing that, whilst their traffic was steadily increasing, the expenses of working their power house were practically stationary. The gross revenue for the half-year had amounted to £45,711, against £36,509 for the corresponding period and £46,239 for the June half of the year. They had expended £22,567 on capital during the six months on additional electrical equipment and power house and generating plant for extension to Finsbury Park in one direction and Lothbury in the other. A further sum of £50,000 for the extension to Finsbury Park was being provided for by the Great Northern Railway. The estimated capital expenditure this half-year was £100,000 for rolling stock ordered, but not delivered, and for extension to Lothbury. 50 per cent. of the gross receipts had been retained by the contractors for working expenses, and they expected to be able to work the railway at a figure which would not exceed that when they took it over in February, 1907. As regarded the Lothbury extension, the money market had not been favourable to the raising of capital. The board had had the matter under discussion, and as soon as the capital could be obtained on reasonable terms, and if the traffic continued to show that increase which would justify them in proceeding with the work, they would take powers to do so.

Sir H. Burdett seconded the resolution, and the report was adopted.

Central London Railway Co.

The report for the half-year ended December 31st, 1905, states that the amount expended on capital account during the half-year has been £4,729. Receipts from all sources of revenue amount to £174,521, a decrease of £1,760, and working expenses to £94,667, a decrease of £1,269, leaving a balance of £79,853 to be carried to net revenue account. The number of passengers carried was 21,694,066, a decrease of 212,084. There has been a slight decrease, about three passengers per 1,000, in the number carried during the year as compared with 1904. The average receipt per passenger for the half-year is 1·85d., as compared with 1·86d. in the half-year ended December 31st, 1904. After providing for interest on debenture stock, and other payments, including the sum of £2,049 expended in opposing competing Bills in Parliament, and transferred from Parliamentary suspense account, the net revenue account shows a balance of £106,000. The directors recommend a dividend on the undivided ordinary stock at the rate of 4 per cent. per annum for the half-year, on the preferred ordinary stock at the rate of 4 per cent. per annum for the half-year, and on the deferred ordinary stock at the rate of 4 per cent. per annum for the whole year. The financial result of the working of the company's undertaking for the year 1905 was as follows:—Balance brought forward from half-year ended December, 1904, £22,112; total net revenue, £171,900, from which must be deducted debenture interest and dividends, &c., £158,618, leaving an unappropriated balance at December 31st, 1905, of £35,393. The directors now recommend that £10,000 be transferred to the reserve fund, bringing the total of that fund, including interest, up to £73,438, the balance of £25,393 being carried forward to the current half-year. In view of the report of the Royal Commission on London Traffic and the public announcement by the Board of Trade of the preparation of a Bill relating thereto, and providing for the establishment of a Traffic Board as recommended in that report, the directors did not think it advisable to incur the expense of redepositing the Bill in the next session of Parliament for the proposed extension of their line, *viâ* Hammersmith, to the City. A Bill has, however, been deposited by other promoters for a line from Hammersmith to Southgate, *viâ* Piccadilly, the Strand, and the City, with various branches, which it will be necessary for the company to oppose. Several electrical power supply and other Bills have also been deposited which may affect this railway, and which will be carefully watched. The subways, referred to in the report for the half-year ended December 31st, 1904, for the exchange of passengers with the Charing Cross, Euston and Hampstead Railway at Tottenham Court Road Station, and with the Baker Street and Waterloo Railway at Oxford Circus Station, are in course of construction, satisfactory arrangements having been concluded with the companies concerned. It is expected that the connection at Oxford Circus Station with the Baker Street and Waterloo Railway will be available for use when that line is opened for traffic.

The twenty-first ordinary half-yearly meeting of the proprietors of this company was held on the 7th inst. at the Holborn Restaurant, Sir Henry Oakley presiding.

The Chairman, in proposing the adoption of the report, said that there had been no alteration in the capital account, and they still had a small balance to the credit of that account. During the half-year they had spent £4,729, £2,000 of which was for the completion of their offices, and the balance for sundry enlargements and additions to their condensing apparatus, which amount had already repaid the cost they had incurred in the saving which had been effected in coal. They had put in the report a possible amount of £20,000 to be expended upon capital during the course of this half year, but really they had no idea of spending that sum or anything like it. The revenue had been going on quietly, with more or less variation, according to the weather and the events of the times. So far as they could form an opinion by comparisons day by day, the elections had to some extent disturbed their business. The trade of the country had not quite recovered, because they found that they had carried some 13,000 less workmen, and, curiously enough, there had been a decrease in the Sunday traffic — why, it was almost impossible to explain. It might be that in fine weather people went by omnibus

or by L.C.C. steamboats into the country, but they had lost in the half-year 316,000 passengers in the traffic on Sundays, compared with those who travelled in the corresponding period. They had not shown that loss—they only showed a loss of 212,000 passengers, the difference being made up by the increase in the week-day passengers—so that it showed that the substance of their business remained unaffected. Judging by the absence of complaints in the Press, he thought that they might claim credit for having done their work fairly well. There had been a diminution in the expenses, but he was sorry to say that there had been an increase in the rates and taxes of about £700. Out of their total earnings of £174,000, they had to pay £15,000 in rates and taxes. Working expenses, without rates and taxes, worked out at about 46 per cent., and with rates and taxes at about 50 per cent., which he thought was a very moderate rate. One bright feature in the report of the past half-year was that since the opening of Kingsway they had found a material increase in the passengers at their Museum Station. That led them to hope that the opening of the Waterloo and Baker Street, and the Charing Cross and Hampstead Railways, with both of which lines they would have exchange stations, would lead to an increase of traffic on their own line at those points. He might mention that each company was paying half the cost of those exchanges. They had spent £2,049 for Parliamentary expenses last year, which was incurred in promoting their Bill to the City, which was necessarily withdrawn. The net result of the half-year was that after bringing that £34,000 into the account, they had a balance of £106,000, which would enable them to pay a 4 per cent. dividend on the original and preferred stocks for the half-year, and 4 per cent. on the deferred stock for the whole year, and after adding another £10,000 to reserve account, it would leave £25,000 to be carried forward. That £10,000 added to the reserve would leave them £73,000, which they had earned in revenue, and which had not been appropriated in any way, and in addition there was the £25,000 to be carried forward, so that in 4½ years they had earned close on £100,000 more than they had divided. They had that sum in their possession untouched, to provide against any exceptional claim or trouble that might fall upon them. Their scheme for the completion of the circle had practically been held in abeyance; first of all during the sitting of the Traffic Commission, and, subsequently, through the action of Parliament. They understood that it was intended to bring into Parliament a Bill authorising the appointment of a Traffic Tribunal for London, to be composed of scientists and men of business who would think out and recommend and settle problems for the future conduct of the transit of the public through London. In the face of this it would have been unwise for them to have put forward any scheme this session. Most other electric railway companies had taken the same view, but there had been one scheme launched, which proposed to begin at Southgate and to pass through the City, going on to Hammersmith and Chiswick. The capital involved was £12,000,000, but he thought it was extremely probable that the scheme would have to be suspended. If, however, it was pressed forward, they would have to oppose it.

Lord Rathmore seconded the motion, and the report was adopted.

Northampton Electric Light and Power Co.

The report for 1905 states that there were 6,335 lamps and motors connected during the year, making a total of 53,766 of 8 c.p. The motors have increased from 351½ to 500 h.p. Of these, 356½ h.p. are hired from the company. The consumers have increased from 801 to 901. The output was 706,590 units, an increase of 24 per cent. over the previous year. A large portion of this increase is for current used for motive power. On March 31st last the directors paid to the holders of the 6 per cent. preference shares out of the surplus revenue of the company the £800 bonus and interest due to them. The £1,000 which still remains to be paid to the holders of the old "first issue" ordinary shares will be paid as soon as the directors have sufficient surplus revenue to meet it. A further sum of £1,800 is added to the depreciation account, in addition to £90 which has been written off motors. The accounts show £1,964 available for dividends. After paying £625 to meet the half-year's dividend on the 5 per cent. preference shares, it is recommended that £988 be applied in paying a dividend of 5½ per cent. for the half-year on the ordinary shares (making 5 per cent. for the year), the balance, £350, being carried forward. The total ordinary dividend for 1904 was 5 per cent.

Dublin United Tramways Co. (1896).—At the annual meeting held on February 6th the report was adopted. The chairman, Mr. W. M. Murphy, said that the output from Ringsend station had increased by 272,286 units, and the actual works cost was £257 less. The cost per unit was ·36d., ·217d. of that being for coal.

London United Tramways (1901).—The directors recommend a dividend on the ordinary shares for the half-year ended December 31st last at the rate of 2 per cent. per annum (making 3 per cent. for the year), carrying £10,000 to reserve fund, and the balance of £1,116 forward. This compares with 6 per cent. for the year 1904, and 8 per cent. for 1903.

Prospectuses.—*Madras Electric Supply Corporation.*—The subscription list opened and closed on Monday last of an issue of 10,000 shares of £5 each, and £250,000 5 per cent. construction debenture stock, both at par. The company is to take up and work a licence for electricity supply granted by the Madras Government to Messrs. Crompton & Co., Ltd., who are the promoters and contractors. Messrs. Crompton will construct and equip a plant for supplying 100,000 8-c.p. lamps, and lay feeders and distributing mains, the total amount of the contract being £174,534. The firm will be the company's contractors and purchasing agents for a period of seven years.

The Copper Mining and Smelting Co. of Ontario, Ltd.—This company has been making an issue of 60,000 $5 shares at par. The list closed last Saturday.

Putupaula (Ceylon) Rubber Estates, Ltd.—Applications have been this week invited for 59,500 shares of £1 each in this company, which has been formed to acquire and work the Putupaula Estate, stated to be "one of the best and most advanced rubber plantations in Ceylon."

India-Rubber, Gutta-Percha and Telegraph Works Co.—A circular has been issued by the company notifying that the 4 per cent. first mortgage debentures for £300,000, and the 4½ per cent. second mortgage debentures for £100,000, will be paid off on 25th prox. An issue of £400,000 4 per cent. first mortgage debentures is to be made at par, and the holders of the existing debentures have the right to take up these.

Great Northern, Piccadilly and Brompton Railway Co.—The report for the half-year ended December 31st states that the capital expenditure during the half-year amounted to £578,643. The estimate for the current half-year is £700,000. The progress of the works during the past half-year has been satisfactory. The rent due up to December 31st from the Underground Electric Railways Co. of London, Ltd., under the terms of the agreement for lease, permits of a dividend at the rate of 4 per cent. per annum.

Chelsea Electricity Supply Co.—The directors have decided to declare a final dividend for 1905 on the ordinary shares at the rate of 7½ per cent. per annum, making 6 per cent. for the year, and a dividend of 3 per cent. on the ordinary shares issued in exchange for the founders' shares, after carrying £10,918 to credit of renewals and depreciation fund account, and writing off £1,891 out of revenue from suspense account, carrying forward £916 as against £1,170 brought in. Last year the ordinary dividend was at the same rate.

Lanarkshire Tramways Co.—The report for the half-year ended December 31st last, states that the receipts were £22,882 and expenses £13,032, leaving £9,849; £2,500 has been placed to reserve for depreciation, £1,249 has been written off, and the directors recommend a dividend at the rate of 5½ per cent. per annum, carrying forward £898. The capital expenditure during the half-year amounted to £48,128, which has been expended mainly on the Larkhall extension and five new cars. Of the shares offered for subscription during the half-year, 4,423 shares were duly applied for and allotted. The dividend rate for the corresponding half of 1904 was 5 per cent. per annum.

South Metropolitan Electric Light and Power Co.—The transfer register of shares will be closed from 15th—28th inst. The dividend to December 31st, 1905, upon the 7 per cent. cumulative preference shares is payable 28th inst.

City of Buenos Ayres Tramways Co.—The report for 1905 states that the annuity payable by the Anglo-Argentine Tramways Co. has been received, and the net revenue for the year amounted to £64,832. The directors recommend a balance dividend of 1s. 3d. per share (making 5s. per share), and transfer £2,750 to general amortisation fund.

City of Carlisle Electric Tramways Co. — The directors recommend a dividend for the past year of 1¼ per cent., carrying £500 to depreciation fund and £416 forward.

Mather & Platt. — The directors have declared an interim dividend at the rate of 6 per cent. per annum for the half-year ended December 31st last. This is at the same rate as last year.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in—

Shanghai Electric Construction Co., Ltd.—317 shares of £1,000 each, £200 paid, Nos. 1 to 317.

And to allow the following securities to be quoted in the Official List:—

United River Plate Telephone Co., Ltd.—Further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 80,000.

The Committee has ordered the undermentioned securities to be quoted in the Official List:—

Charing Cross, Euston and Hampstead Railway Co.—£800,000 4 per cent. perpetual debenture stock, in lieu of Speyer Bros.' scrip certificates now quoted.

Held Over.—Pressure upon our space compels us to hold over the reports of several companies until next week.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fort-night ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Feb. 10	2,253	+ 44	37	51,020	— 936	..	..
Ayr	,, 3	352	+ 12	35	11,119	— 109	8	..
Bath	,, 7	1,200	+ 154	6	3,817	+ 631	13	..
Belfast	,, 9	5,815	+1,252	6	17,433	+ 4,018	40	+ 6¼
Birkenhead	,, 11	1,909	— 73	45	46,673	— 577	13·5	..
Blackburn	,, 7	1,328	+ 54	35½	43,916	+ 2,211	13·75	..
Blackpool Corp.	,, 8	635	+ 22	45	47,255	+ 1,995	11·87	..
,, —Fleetw'd	,, 10	357	— 2	6	1,042	— 39	..	..
,, —Lytham	,, 8	296	+ 32	14	2,107	+ 239	7½	..
Bolton	,, 11	3,511	+ 172	46	87,905	+ 4,274	26	+ 1
Bournemouth	,, 7	2,603	+ 808	44½	63,463	+14,695	17·4	+ 7¼
‡Bradford	,, 10	3,828	+ 11	45	196,104	— 2,983	53	..
Brighton	,, 11	1,423	— 92	46	45,260	..	9·5	..
Bristol	,, 9	9,050	+ 35	..	..	..	28·5	..
Brit. Elec. Trac. Co								
Airdrie	Feb. 2	422	+ 34	5	1,066	+ 122	8·5	..
Barrow	,, 2	358	+ 38	,,	918	+ 92	5·37	..
‡Birmingham (City)	,, 2	10,362	+ 22	,,	24,514	— 311	14·5	..
Birmingham (Mid.)	,, 2	2,702	— 610	,,	6,344	— 1,342	12·25	..
Devonport	,, 2	810	— 22	,,	1,977	— 82	8·85	..
Dudley—Sto'rb'ge	,, 2	1,481	+ 77	,,	3,490	+ 303	21·25	..
Gateshead	,, 2	1,842	+ 117	,,	4,331	+ 304	11·25	..
Gravesend, N'fleet	,, 2	385	+ 24	,,	925	+ 72	6·5	..
Gr'n'k, Pt. Glsgw	,, 2	1,089	+ 97	,,	2,680	+ 265	7·25	..
Hartlepool	,, 2	5.5	+ 60	,,	1,201	+ 95	6·72	..
Leamington	,, 2	245	+ 60	,,	628	+ 200	..	..
Merthyr	,, 2	340	— 19	,,	804	+ 3	2·9	..
‡Metropolitan	,, 2	5,490	+1,809	,,	12,954	+ 4,270	..	..
Middleton	,, 2	561	+ 44	,,	1,320	+ 146	8·5	..
Oldham — Ashton	,, 2	1,022	+ 47	,,	2,378	+ 139	9·13	..
Peterborough	,, 2	188	— 6	,,	458	— 4	5·31	..
Potteries	,, 2	8,414	+ 161	,,	8,130	+ 563	29	..
Rothesay	,, 2	88	+ 16	,,	260	+ 47	2·75	..
Southport	,, 2	466	+ 48	,,	1,118	+ 85	8·17	..
South Staffs.	,, 2	1,566	+ 316	,,	3,597	+ 707	13·87	..
Swansea	,, 2	1,404	+ 502	,,	3,377	+ 1,289	5·5	..
Tynemouth	,, 2	326	— 7	,,	773	— 8	3·75	..
Weston-s-Mare	Jan. 31	55	+ 6	,,	119	..	3	..
Wolverhampton D.	Feb. 2	740	+ 60	,,	1.691	+ 153	14·75	..
‡Worcester	,, 2	158	— 35	,,	1,141	— 11	5·75	..
Yorks. Wool. Dist.	,, 2	1,694	+ 569	,,	3,842	+ 1,463	17	..
Miscellaneous	,, 2	325	+ 18	,,	2,117	+ 19	..	..
Burnley	,, 10	2,112	+ 51	..	..	..	7·5	..
Burton-on-Trent	,, 11	494	— 90	45	13,857	..	8·5	..
Bury	,, 4	1,551	..	44	33,457	..	10·5	..
Cardiff	,, 3	3,644	+ 53	44	90,042	+ 114	15·8	..
Carlisle	,, 10	314	+ 35	6	967	+ 90	..	..
Chatham and Dist.	,, 8	1,151	— 31	6	3,807	+ 24	9·33	+ 8
Cheltenham	..	..	..	..	..	..	..	..
Colchester	,, 7	314	+ 5	28	5,173	— 1,380	7½	+ ½
Cork	,, 8	817	— 2	6	2,325	+ 3	9·89	..
Coventry	Dec. 14	815	+ 8	50	23,960	+ 642	9·89	..
‡Darlington	Feb. 3	188	+ 2	44	8,971	..	4·87	..
Darwen	,, 9	219	+ 10	45	10,948	+ 665	4·34	..
Dover	,, 10	348	+ 24	45	10,100	+ 59	4·75	+ 1½
Dublin	,, 9	9,060	— 19	6	26,392	+ 978	48·5	+ ·5
Dundee	,, 7	1,954	+ 348	38	35,882	+ 3,005	12·5	..
East Ham	,, 10	1,528	+ 252	45	37,283	+ 5,198	8	+ 1½
Exeter	..	..	..	..	..	..	..	..
Glasgow	,, 10	30,233	+2,281	36	562,282	+36,228	76	+ 2·5
‡Gloucester	,, 7	216	— 5	45	13,009	+ 1,157	15	..
Halifax	,, 7	2,629	+ 245	45	70,196	+ 5,118	37	+ 2·5
Hastings	,, 9	669	..	..	..	..	..	..
Huddersfield	,, 10	2,616	+ 219	45	61,476	+ 3,440	28	..
Hull	,, 10	4,269	+ 185	45	100,609	+ 2,003	13	..
Ilford	,, 10	772	+ 57	45	21,076	+ 949	..	..
Ilkeston	,, 7	219	+ 8	45	5,308	— 700	3·5	..
Ipswich	,, 10	613	— 42	45	19,117	— 1,871	10·5	..
Isle of Thanet	,, 10	424	— 43	6	1,367	+ 18	..	..
Kilmarnock	..	..	..	..	..	..	..	..
Kirkcaldy	,, 7	380	— 9	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 8	1,636	+ 405	6	4,905	+ 440	12·5	+ 3·9
Leeds	,, 3	11,139	+ 686	45	264,850	+ 8,590	89·5	+ 8
Leicester	,, 10	3,947	+ 385	6	11,712	+ 1,735	..	..
Leith	..	..	..	..	..	..	..	..
Lincoln	..	..	..	..	..	..	..	..
Liverpool	,, 3	20,133	+ 756	5	50,401	+ 2,413	104	+ 1
L.C.C.	Jan. 27	27,548	+4,020	43	634,308	+85,992	51	+ 4½
Lowestoft	Feb. 10	229	— 21	19	2,710	— 22	3·5	..
Manchester	,, 10	24,332	+1,140	45	578,912	+29,080	..	..
Nelson	..	..	..	..	..	..	..	..
‡Newcastle	,, 3	3,745	+ 19	44	167,942	+ 4,621	..	..
Newport	,, 3	1,069	+ 77	18	9,871	+ 632	14·5	+ 1·5
Northampton	..	..	..	..	..	..	..	..
Oldham	,, 11	2,945	+ 179	46	74,947	+17,303	23·75	+ 1·6
Plymouth	..	..	..	..	..	..	..	..
Pontypridd	,, 10	288	..	45	7,218	..	3·5	..
Portsmouth	,, 10	2,831	+ 46	45	87,508	+ 1,700	14·5	..
Preston	,, 7	1,148	..	..	..	..	..	..
‡Reading	Jan. 18	603	+ 67	42	26,603	— 477	..	..
‡Rochdale	Feb. 10	708	+ 301	45	35,248	+23,417	21·3	+ 5·8
Rotherham	..	..	..	..	..	..	..	..
Salford	,, 5	8,031	+ 362	45	191,654	+11,294	..	..
‡Scarborough	Nov. 25	49	..	46	7,735	..	4·5	..
Sheffield	Feb. 11	9,214	+ 606	46	227,198	+13,174	35·75	-1·5
Southampton	,, 7	1,658	+ 68	18	16,107	— 31	..	..
Southend-on-Sea	,, 7	467	+ 22	45	16,736	+ 1,031	6	..
Stalyb'dge, Hyde, &c.	,, 3	1,144	+ 327	44	28,083	..	21	..
Stockport	,, 2	1,477	+ 646	44	33,510	+ 9,310	15·5	+ 4
Sunderland	,, 11	2,366	+ 178	45	59,586	+ 2,683	..	..
Swindon	,, 7	340	..	45	8,759	..	4·4	..
Tyneside	Jan. 31	684	+ 38	5	1,503	+ 31	8·87	..
Wakefield	..	..	..	..	..	..	..	..
Warrington	,, 25	529	+ 36	43	14,719	+ 923	6·37	+ ·25
West Ham	Feb. 8	3,869	+1,715	44	82,730	+35,673	14·7	+ 4·9
Wolverhampton	,, 7	1,431	..	..	..	..	10	..
Cen. London Rly.	,, 10	13,897	— 300	6	41,772	— 1,427	6	..
City & S. Lon. Rly.	,, 11	5,956	+ 155	6	18,166	— 14	6·25	..
Dublin-Lucan Rly.	,, 9	164	— 31	6	493	— 63	17	..
G. N. and City Rly.	,, 10	3,599	+ 65	6	10,823	+ 192	3·5	..
L'pool Overh'd Rly.	,, 11	2,733	— 270	6	8,371	— 529	6·75	..
Mersey Railway	,, 10	5,335	+ 108	6	16.151	+ 305	4·5	..
Metropolitan Rly.	,, 11	33,092	— 290	6	101,915	— 463	70·5	
Met. District Rly.	,, 11	16,017	+ 957	6	48,558	+ 3,008	24	
Anglo-Argentine	,, 11	29,249	+3,493	6	87,686	+ 8,574	..	..
§Auckland, N.Z.	,, 2	9,782	+ 398	5	11,964	+ 488	18·6	..
Brit. Columbia Rly.	Dec.	21,953	+3,510	26	123,211	+27,557	..	..
Bu'n's A'r's E.T. Co.	Jan. 13	3,000	..	..	..	..	..	..
Bu'n's A'r's-Belgr'no	Feb. 11	6,927	+ 686	6	21,182	+ 2,115	..	..
Calcutta	,, 10	5,747	+ 753	..	..	..	..	..
§Geneva	Dec.	6,496	+ 89	..	..	..	..	..
Perth (W.A.)	Feb. 9	3,358	+ 298	6	9,405	+ 521	24·25	+ 5½

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

STOCKS AND SHARES.

Wednesday afternoon.

Money, according to the Lombard Street experts, is already becoming cheaper, although a reduction in the Bank Rate cannot be looked for immediately. The Stock Exchange keeps Consols good, largely on the change of Government, with its promises of retrenchment, sinking-fund restoration, and so forth. Home Railway stocks are flabby and profitless, electric issues maintaining fair steadiness amidst general depression. Lighting shares waver, and the telegraph list is distinguished by no outstanding feature of interest.

Numbers of securities were quoted *ex* dividend last week, and the Central London trio show losses equivalent to the distributions in each case. City and South London is *ex* 17s. 6d., but the price is left at 42: it will not be long before the first results of the new Kingsway-to-Islington competition have a chance to show their malign powers. No alteration occurred in Waterloo and City stock. At Tuesday's meeting of the company, the chairman said that the question of terms by which the London and South-Western would acquire their undertaking had been neither settled nor mentioned.

Several weeks ago it was remarked here that what the electric supply market feared more than anything was the possible references of London's power needs to a Royal Commission. That this apprehension was intelligently based is seen in the Corporation of London's intention to ask the Government to appoint a Royal Commission to consider the whole question of electric supply in bulk. This matter comes before the Corporation to-morrow (Thursday), and there is not much doubt in the market as to its fate. Shares in this department, however, are fairly firm, with the exception of Charing Cross Ordinary, which fell 15s. upon the decrease in the dividend from 8 per cent. to 5 per cent. The price rallied a trifle to 5½, but the increased Parliamentary expenses, to which the reduced dividend is apparently due, are not relished. The Preference are ¼ down, *ex* 2s. 3d., and both classes of the "City" Preference lost 5s. Westminsters continue on the upgrade, with a rise of a like sum, and London Electric Preference also added 5s. upon the favourable report. The "little" shares are mostly better, Smithfield Ordinary rising as much as 10s., and South Londons ⅛, each following upon advances last week, and this in spite of the fact that the latter company's report shows a reduction in net revenue as compared with 1904. Holders of Edmundson's Ordinary are viewing with some anxiety the continual shrinkage in the price of their shares. It has again shed ¼, and is down to 5. We are afraid that there is not much doubt as to a fall in the next dividend, which may make 5 per cent. for the year instead of the regular 7 per cent. The company, one may perhaps guess, finds that promises held out by interests in power concerns do not materialise as soon as many expected them to do; in which connection it is noteworthy that South Wales Electric Power shares, for example, are about 7⅛, and very difficult to sell at that reduced level. Urban fell ⅛ to 4⅝ in sympathy with the Edmundson's weakness.

In traction issues British Electric Ordinary exhibit another fall, this time of 5s., the price now standing at 8. Argentine varieties are steadily good, the tendency being to improve. The rise in London United Tramway did not hold, and the quotation has slipped back to 9¼, the Debentures also easing to 94½. Underground Notes are a trifle harder at 99, but Districts at 33¼, and Metropolitan Consolidated at 82 remain weak. The latter stock is *ex* dividend. Districts, to quote a hoary jest, are *cum* dividend.

Both the horse-omnibus companies' stock and shares are flat, despite a favourable report issued by the Road Car Co. The quotations of the London Motor, Motor 'Bus and District Motor shares are 1⅞, ⅜ premium, and 1¼ respectively. A new comer invites subscriptions to a motor-omnibus service for Edinburgh. Its prospectus is not so attractive as that of the Madras Electric Supply Corporation. In the latter case the lists were only open for a few hours, and the Debenture stock is already 5 premium.

Anglo-American Telegraph Deferred is again active, and the price has risen over 18, *ex* its 10s. dividend. A distribution of 30s. for 1905 is the latest rumour—the announcement will come next January! Some of the older members in the market recall the days when Anglo "B," the Preferred stock, used to be quoted in the nineties, whereas the "A," the Deferred, was then in the forties, and in receipt of no dividend at all. Now the situation has completely changed, of course, the "B" standing at 110½, *ex* 32s. dividend, and the "A" at 18⅛. Western Telegraphs rose to 14⅜, and Eastern Extensions to 15, an advance of ⅛ in each instance; but the Eastern group on the whole is surprisingly immobile. Globe Telegraph Preference put on ⅛ at 14⅜, and Submarine Cables Trust certificates responded to a United States inquiry by rising 2 points. Marconi's relapsed ¼ to 1⅛ after their hot rise. The only change amongst telephones is the restoration of the point lost last week by Oriental 4 per cent. Debenture stock. Reference is made in the report of the National Telephone Co. to a new issue, and it is thought that the company will probably take powers to raise more capital in the shape of Ordinary stock.

Manufacturing varieties incline to strength, although British Insulated are ¼ easier at 7. But Brush Ordinary rose ⅛ to ⅝, the Preference ⅛ to 1⅜, Electric Constructions ⅛ to 2¼, and General Electric Preference ¼ to 9½. Henley's firmed up to 13½ again. Babcock & Wilcox have not changed.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME,	Stock or Share. †	Dividends for the last four years. 1902.	1903.	1904.	1905. §	Closing Quotations Feb. 7th.	Closing Quotations Feb. 14th.	Business done week ended Feb. 14th, 1906. Highest	Lowest	Rise + or Fall −
17,700	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	4 %	98½—101½	98½—101½	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3⅝— 4¼	3⅝— 4¼	4	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	83 — 88	83 — 88	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	23/6	31/6	65 — 67	64 — 66 xd	..	..	..
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5⅝ %	6 %	112½—113½	110½—111½xd	111⅜	110½	..
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	1/6	17⅛— 18⅛	18 — 18½xd	18⅛	17⅛	..
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	102 —104	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	8 — 8½	8 — 8½	..	..	— ⅛
1,932,856£	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99⅛	97 — 99	99¼	98½	..
16,000	Cuba Telegraph	10	6¾%	10 %	5 %	5 % §	8½— 9	8½— 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 % §	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 % §	8⅜— 8⅝	8⅜— 8⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 % §	8½— 8⅝	8½— 8⅝	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..
60,710£	Direct United States Cable	20	3⅝%	3 %	3⅛%	3⅜%	14½— 15½ xd	14½— 15½	15¼	14¹⁵/₁₆	+ ½
70,000	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200,R.	100	4½%	4½%	4½%	4½%	99 —101	99 —101	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 % §	148 —151	148 —151	150¼	149¼	..
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	3½%	3½% §	92 — 94	91½— 93½	92⅝	91¾	— ⅛
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 % §	109 —109½	107⅞—109½	108¼	108	— ⅛
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 % §	14½— 15	14⅜— 15⅛	15	14¹³/₁₆	+ ⅛
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 % §	107 —109	105 —107 xd	..	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101 xd	99 —101	..	..	+2
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 3,000	25	4 %	4 %	4 %	4 %	101 —103	101 —103	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5⅛%	5⅛%	5 %	11⅛— 11⅜	11⅛— 11⅜	..	..	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅛— 14⅜	14⅛— 14⅜	..	..	+ ⅛
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	..	37½— 39½	37½— 39½	38	..	..
42,300	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	—1
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	5 %	57 — 59	57 — 59	58½	57	..
251,127	Marconi's Wireless Telegraph	1	..	..	..	..	1⅛— 1⅜	1⅛— 1⅜	30/7½	..	— ⅛
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞— 1	⅞— 1	..	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅞— 1	⅞— 1	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	113½—114½	113¾—114½	114⅛	113½	+ ⅛
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	110 —112	110 —112	111¼	110½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	13 — 15	13 — 15	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	12⅛	12	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅝— 5¾	5⅝— 5¾	5⅝	..	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	99½—100½	99½—101½	99½	..	+ ⅛
1,689,593	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	104 —106	103½—105½	105	104½	— ⅛
179,313	Oriental Telep. and Elec. 1 to 171,504,fully paid	1	6 %	6¼%	6¼%	6 %	1⅞— 1⅞	1⅞— 1⅞	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1½— 1⅝	1½— 1⅝	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	96 — 98	97 — 99	97	..	+1
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 % §	7½— 7⅞	7½— 7⅞	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	103 —106	103 —106	..	..	—1
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	125—128	127 —130	..	..	+2
70,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7⅛— 7⅜	7⅛— 7⅜	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5⅜	..	..
179,947	Do. do. 5 % Debs.	Stocks	5 %	5 %	5 %	5 %	110 —112	110 —112	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9½— 10	9½— 10	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	⅝— ¾	⅝— ¾	12/6	..	— 1/6
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	— ⅛
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14½— 14⅝	14½— 15	14⅝	14⅝	+ ⅛
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	100 —102	100 —102	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102 —104	102 —104	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜— ½	⅜— ½	..	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	6 %	8½— 8⅝	8½— 8⅝	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6⅞— 7⅛	6⅞— 7⅛	6⅞	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	100 —103	100 —103	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 % §	8⅞— 9⅛	8⅞— 9⅛	9¹⁵/₁₆	8¹⁵/₁₆	— ⅛
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5¹⁵/₁₆— 6¹/₁₆	5⅞— 6⅛	6⅛	6	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	140 —143	141 —144	142	..	+1
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	104 —106	104 —106	..	..	..
800,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	16 % ‖	4 — 4¼	3⅞— 4¼	83/9	81/3	— ⅛
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1¹⁵/₁₆— 1¹/₁₆	1¹⁵/₁₆— 1¹/₁₆	..	..	+ ⅛
38,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	..	..	1⅝— 2⅛	.. — ..	..	..	..
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	Nil	3/6	5½— 6	5⅝— 6	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	3/-	5 — 5½	5 — 5½	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	3 — 3½	3 — 3½	..	..	— ⅛
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	98 —102	98 —102	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	120 —123	120 —123	..	..	..
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	110 —113	110 —113	111⅜	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	108 —111	108 —111	108	..	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103 —105 %	103 —105%	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
133,301	British Electric Traction	10	8 %	6 %	6 %	..	8 — 8¼	7⅞— 8¼	8	7¹⁵/₁₆	— ⅛
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 % §	10½— 11	10½— 10⅞xd	10¹¹/₁₆	10½	..
1,415,422£	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	119 —121	119 —121	120⅛	119	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	98 —100	98 —100	..	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 % §	7 — 7⅛	6⅞— 7⅛	..	..	— ⅛
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 % §	5⅞— 6¼ xd	5⅞— 6¼	..	..	+ ⅛
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	103 —106	103 —106	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	98 —100	98 —100	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1⅞— 2¼	1⅞— 2¼	42/6	41/3	..
1,016,353	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 82	77 — 82	80	79½	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	⅝— ¾	⅝— ¾	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	+ ⅛
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	..	⅜— ½	⅜— ½	11/-	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1¾— 1⅞	1⅞— 2	37/6	33/9	..
125,000£	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	98 —100	98 —100	..	..	+1
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3⅜— 3⅞	3⅜— 3⅞	75/7½	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5¼— 6¼	5¼— 6¼	..	..	— ⅛
27,500	Do. "B" do. 1 to 27,500	5	..	6 %	6 %	..	5¼— 5⅝	5¼— 5⅝	5⅝	5½	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	105 —107	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	..	..	—1
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 % §	9½— 10	9½— 10	..	..	..
32,610	Do. 105,001to 137,610	5	..	..	..	3d.	9 — 9¼	9 — 9¼	..	..	— ⅛
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4 %	4½%	104 —106	104 —106	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	10%	11 — 12	11 — 12	11⅛	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5¾	5⅝— 5¾	5⅝	5⅝	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108½—110½	108½—110½	109½	..	— ⅛
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 % §	⅞— 1⅛	⅞— 1⅛	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	1¹⁵/₁₆— 1¹/₁₆	1¹⁵/₁₆— 1¹/₁₆	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	95 —100 xd	95 —100	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	95 — 97	93 — 95 xd	95	93	+2
530,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	104 —106	102 —104 xd	104	103	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	87 — 90	83 — 86 xd	84⅞	84½	..
1,480,000	City and South London Railway	Stock	3½%	2⅞%	2½%	1⅞%	41 — 43	41 — 43 xd	42	40⅝	..
85,000	Crompton & Co., Nos. 1 to 85,000	3	5 %	2½%	2½%	..	2 — 2¼	2 — 2¼	43/1½	41¼	— ⅛
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	96 — 99	95 — 98	97½	..	—1

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

Continued on next page.

* Compared with the corresponding period.
‡ Includes horse, steam and other receipts.
§ One month.

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Feb. 7th.	Closing Quotations Feb. 14th.	Business done week ended Feb. 14th, 1906.		Rise + or Fall—
		†	1902.	1903.	1904.	§1905.			Highest	Lowest.	
52,000	Dick, Kerr & Co., 1 to 52,000	5	..	..	10 %	..	8½ — 9	8½ — 9	8¾	..	..
61,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	6 — 6½	6 — 6½	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	104 —106	104 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½%	6 %	6 %	13¾— 14½	13¾— 14¾ xd	..	..	+ ¼
59,987	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14½— 15½	14½— 15½ xd	..	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	4 %	99 —101	99½—100½	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½%	3½%	3½%	98 —100	99 —101	..	..	+1
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½%	3½%	3½%	96 — 98	97 — 99	..	..	+1
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½%§	..	1¼— 1⅜	1¼— 1⅜	..	..	..
17,189	Do. "A" shares, 01—017,189	5	Nil	Nil	2½%§	..	2¼— 2⅜	2¼— 2⅜	..	..	..
344,023‡	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	86 — 88	..	..	..
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	⅜— ½	⅜— ½	..	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	7 %	7 %	7 %	..	1⅝— 2⅜	2 — 2¼	..	..	+ ⅛
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	89 — 92	89 — 92	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9 — 9½	9¼— 9⅜	9⅜	9⅛	+ ¼
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	95 — 99	95 — 99	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	5⅜— 5⅝	4¾— 5⅛ xd	98/9	97/6	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½— 11½	10½— 11½	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —103	102 —104	..	..	+ ½
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	10%§	12¾— 13¼	13 — 14	13⅝	13¼	+ ½
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5¼— 5⅜	5¼— 5⅜	..	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	.. — ..	.. — ..	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	10%	18 — 19	18 — 19	18⅛	18	..
800,000‡	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅜%	1½%	Nil	1⅞— 2⅛	1⅞— 2⅛	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6½— 7	6⅝— 6⅞	..	..	+ ⅛
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	4 %§	10 — 11	9⅝— 10⅜	..	..	— ⅜
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	4 %§	4 — 5	3⅜— 4⅜	..	..	— ⅜
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	9½— 9⅝	9 — 9⅛	9	8⅞	— ⅓
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	92 — 97	93 — 96	96¼	94½	..
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	..	⅜— ⅝	⅜— ⅝	5/-	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1 — 1⅛	1— 1⅛ xd	19/9	..	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	104 —106	104—106	..	..	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	5 — 5½	4¾— 5¼	..	..	— ¼
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8¾— 9¼	8¾— 9¼	9⅛	..	— ¼
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¾— 10⅛	9¾— 10	..	..	— ¼
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 — 106	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	34 — 36	34½— 36½	35¾	34½	+ ½
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	98 — 99	98 — 100	98¼	98⅛	+ ½
540,000	Waterloo & City Railway, Ord.‡Stock	100	3½%	3½%	3½%	3½%§	97 —100	97 — 100	..	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8½%	6 %§	..	..	2 — 2¼	2¼ — 2⅜	50/-	●47/6	+ ½
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	..	..	4 — 4⅛	4 — 4⅛	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	82 — 87	82 — 87	85	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 %§	5⅛— 5⅜	5⅛— 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%§	102 —105	103 —106	..	..	+1
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	9 %	8½— 9⅛	8¾— 9⅛	8¾	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	8¾— 9⅛	8¾— 9⅛	8⅞	8½	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	102 —105	102 —105	10⅜	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %§	5⅜— 6⅛	5 — 6	5⅜	5	— ⅛
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	5⅛— 5⅜	5 — 5⅛ xd	5⅛	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4⅜— 4⅝	4¼— 4⅜	87/6	..	— ⅛
40,000	Do. do. 1903	5	..	4½%	4½%	4½%	4⅜— 4⅝	4¼— 4⅜	..	..	— ⅛
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —103	101 —103	..	..	..
44,496	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5 — 6	5 — 6	..	..	..
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	5 %	11 — 12	11 — 12	11¼	11¼	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	13¾— 14½	13¾— 14½	..	..	..
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	122 —126	122 —126	124	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
40,000	County of Durham Electrical Power, Ord.	2	..	..	..	..	1⅛— 2 1/16	1⅞— 2	..	..	— ⅛
50,000	Do. do. do. 5 % Pref.	5	..	..	..	..	5⅛— 5⅜	5 — 5¼	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	4 %§	8½— 9¼	8¾— 9⅛	9⅛	9⅛	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	12⅝— 13	12⅝— 13	..	..	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	109 —112	109 —112	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —103	101 —103	102⅜	101⅞	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	5 %§	5 — 5⅛	4⅞— 5⅛	4⅞	..	— ⅛
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	5 — 5⅜	5⅛— 5⅜	5⅜	..	+ ⅛
820,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	104 —106	104 —106	105	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	4 %§	5¼— 5⅜	5¼— 5⅜	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅜	5 — 5⅜	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	102 —105	101 —104	..	..	—1
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	8 %	8⅛— 8⅜	8⅛— 8⅜	..	..	..
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	8 %	7⅞— 8⅛	8 — 8⅜	..	..	+ ⅛
37,303	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —101	98 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	98 —101	98 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½%	12 %	10 %	10½— 11½	10½— 11½	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	2 — 2⅛	2 — 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	5 — 5⅜	5⅛— 5⅜	5⅜	5⅛	+ ⅛
374,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %§	9 — 10	9 — 10	9⅜	9¼	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅛— 5⅜	5⅛— 5⅜	5⅜	5 1/16	..
220,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	107 —111	107 —111	..	..	..
250,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	101 —103 %	100 —103 %	..	..	..
57,009	Newcastle-on-Tyne, 1 to 57,009	5	..	8 %	8 %	2½%§	8 — 8¼	8 — 8¼	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	2/4½	8 — 8¼	8 — 8¼	..	..	..
57,009	Do. 5 % Pref., 1 to 57,009	5	..	5%	5	5 %	6½— 6⅝	6½— 6⅝	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	2/4½	6½— 6⅝	6½— 6⅝	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	6 %	13½— 14½	13¾— 14½	..	..	..
64,000	Do. do. 4 % 1st Mort.Deb.	100	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	5 %§	6⅝— 6⅞	6⅝— 6⅞	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	98 —100	..	..	—1
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	11 — 12	11 — 12	11⅜	..	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	7⅞	7⅞	..
150,000‡	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	97 — 99	97 — 99	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	2¼— 2⅜	2⅜— 3⅛	3	37/6	+ ⅛
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	76 — 80	76 — 80 xd	..	..	..
65,000	South London Electricity Supply, Ord.	5	1½%	3 %	4 %	..	3¼— 3⅜	3⅜— 3⅞	73/9	66/9	+ ⅛
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	..	⅜— ⅝	⅜— ⅝	..	..	..
85,368	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1 1/16— 1 1/8	1⅛— 1⅜	26/10½	..	— 1/16
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	105 —108	105 —108	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	4⅜— 4⅞	4¼— 4⅜	91/3	..	— ⅛
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5 1/16	5⅛	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	104 —106	104 —106	105½	105¼	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13 %	10⅝— 11⅜	11 — 12	11⅝	11¼	+ ½
28,151	Do do. 4½ % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	5⅜	..	..

Shares not officially quoted :—Mackay Companies, ord., 63½—64½. Pref. 76—77.
† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 4 per cent. (September 28th, 1905).

A CONTRIBUTION TO THE THEORY OF THE SINGLE-PHASE INDUCTION MOTOR.

By VAL. A. FYNN.

(*Continued from page* 204.)

It is seen that in the single-phase induction motor we have two alternating fields displaced in space by $\frac{180}{n}$ degrees and differing in phase by practically 90°. These fields are necessarily excited by currents also differing in phase by practically 90°. Such motors are therefore really two-phase motors operated from a single-phase supply, they themselves generating by rotation the second phase, necessary for their operation. This expression, "two-phase motors," is, however, not used here in its usual acceptance. What is generally understood to be a two-phase motor is one which derives the energy

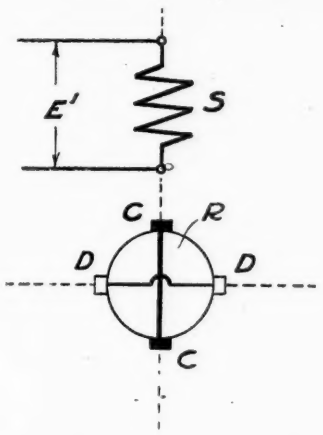

Fig. 1.

necessary for its operation in materially equal quantities from both phases, but such is not the case here. In the case of the single-phase induction motor, one of the phases (*i.e.*, that directly derived from the supply) conveys the energy necessary for the operation of the motor; the other phase, derived from the first by rotation, only supplies the excitation of the motor. A motor of this type can be operated from a two-phase supply, but will put a very unequal load on the two phases.

Here we have a further analogy with the ordinary shunt motor. It is well known that a continuous current series motor with laminated fields can be operated on an alternate current circuit, and will give good results provided care is taken to keep the self-induction of the field winding low, and to eliminate the armature self-induction by means, for instance, of a compensating winding disposed on the field structure. These dispositions ensure a near coincidence between the phase of the motor field and that of the armature current. If, however, it is attempted to operate a continuous current shunt motor with laminated fields from a single-phase supply, it is found that no power can be obtained from the machine, the reason being the practical impossibility of bringing about coincidence between the phase of the motor field and the phase of the armature current. In order to get a good output for weight out of such a machine, the self-induction of the armature ought to be reduced as far as possible, and at the same time the phase of the armature current should coincide exactly with the phase of the motor field. The only way to achieve this, when working directly from a single-phase supply, would be to eliminate all self-induction from the field winding—an obviously impossible task.

All these difficulties disappear when such a motor is operated from a two-phase supply, as shown in fig. 2. The armature R connected in series with the compensating winding K receives the energy necessary for the operation of the motor from one of the phases E^1; the field is excited off the other phase E^2 by means of the winding F. In this case the armature current is conveyed to the alternate-current shunt motor by conduction, and the armature self-induction is compensated by the coaxial winding K. The phase of the E.M.F. impressed on the armature is in quadrature with the phase of the E.M.F. impressed on the field winding. There being very little self-induction in

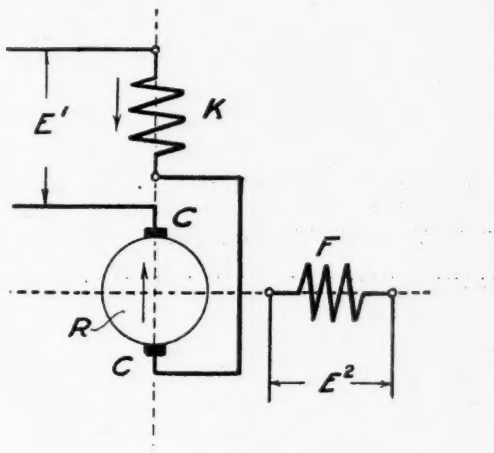

Fig. 2.

the armature circuit, the current in that circuit will be in phase with its E.M.F. The field due to E^2 will be in quadrature with that E.M.F., and consequently in phase with E^1 and the armature current. The back E.M.F. in the armature will be due to rotation in the field set up by F, and will be cophasal with it, therefore cophasal, or nearly so, with E^1. We have seen that in the case of the induction motor exactly the same relations exist between the various factors governing the operation of the motor, but with this difference, that the working E.M.F. impressed on the armature is conveyed by induction and not by conduction, and that E R, the E.M.F. responsible for the motor field, which corresponds to E^2 in fig. 2, is set up in the motor itself by rotation of the rotor conductors in that transformer field, which also serves to convey E T. Another but immaterial difference consists in that in fig. 2 the winding responsible for the motor field is disposed on the stator, whereas in the induction motor the rotor winding itself is made use of, not only as an armature, but also as a field winding; indeed, the

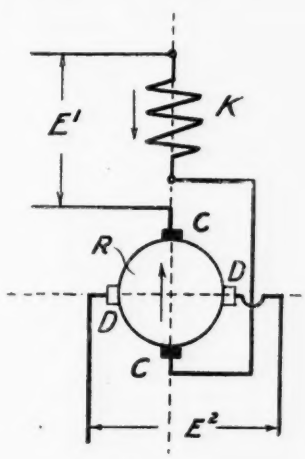

Fig. 3.

nature of the motor would be in no way altered if in fig. 2 the winding F were discarded and E^2 were applied directly to the armature along the motor field axis as shown in fig. 3.

The theory which has been here put forward affords an

easy explanation for all the well-known properties of the single-phase induction motor. The reason why such a motor will not start without special and often troublesome devices, is very simple. We have seen that the torque is due to the current in the rotor along the axis C C (the armature or working current), and the motor field along the axis D D. The torque will be nil when either of these factors is zero, or when the two factors, whilst differing from zero, happen to be in quadrature as regards phase. Now, in the single-phase induction motor as hitherto constructed, the motor field depends on E R, the E.M.F. set up along the axis D D by rotation in the transformer field; as long as there is no rotation E R must be zero, there can be no field and consequently no torque.

It might appear strange at first sight that an induction motor which will not start by itself, will run up to speed with equal facility in *either* direction if, by some means or other, it is given a sufficient initial impetus. The explanation of this phenomenon is now also sufficiently obvious. We know that the direction of rotation of a continuous current motor will be reversed if the direction of its field *or* that of its armature current be reversed. Assuming, in the motor under consideration, a transformer field of a certain direction, it is clear that the direction of E R will depend on that in which the rotor is rotated within that transformer field. The direction of the working current being dependent on that of the transformer field only, it is evident that the direction of the torque will alter with that of E R, since a change in the direction of E R, brought about by a change in the sense of rotation, also changes the direction of the motor field independently of that of the working current.

When the motor has been brought up to a speed sufficient to build up a motor field of the strength required to produce, in conjunction with the working current, a torque which is able to overcome the resistance offered, then the motor will continue to run by itself and will reach its normal speed, the motor field increasing with the speed. It would seem that a motor starting light ought to run up from a very moderate initial speed, since the resistance to be overcome is mainly that due to friction and to the slow acceleration to be imparted to a not very heavy rotor. With the heavy current in the transformer axis at the moment of starting, a very weak field would seemingly be sufficient; this would, indeed, be the case, if it were not for the very appreciable phase difference which exists between these two factors at that moment. At standstill or at very low speeds, when E B has not yet reached an appreciable value in comparison to E T, the conditions in the transformer axis are practically those of a short-circuited transformer, and the working current (rotor current in the axis C C) lags behind the transformer field by an angle much more nearly approaching 180° than 90°. Now, whatever the magnitude of the motor field built up by rotation, its phase will always be very nearly in quadrature with that of the transformer field, and at starting will consequently be also nearly in quadrature with that of the working current—a fact which accounts for the low starting torque. The higher the resistance of the rotor windings, the less will the working current lag behind the transformer field. The resistance of the rotor windings in the smaller motors is, as a rule, greater in proportion than that of the larger motors; the former will consequently run up to speed very much more easily.

Given a certain direction of rotation, the direction of the torque will remain unchanged if the direction of the transformer field be changed. A change in the direction of this field does not only bring about a change in the direction of the working current, but also a change in that of the motor field, because the rotor conductors, although revolving in the same sense, now cut a field of opposite direction. This is why these motors will work on alternate current circuits, and why a reversal of connections between stator and line does not affect the direction of rotation.

The speed of the single-phase induction motor drops very little with increasing load, and the smaller the rotor resistance the smaller the drop. Assuming for the moment that the motor field remains constant, then the amount of drop in speed would be simply governed by the resistance of the rotor and the magnitude of the current required in the axis C C to produce, in conjunction with that constant motor field, the torque corresponding to the increased load. The author has shown that this current depends on E W, the resultant E.M.F. in the transformer axis of the rotor, and mainly on the difference E T—E B. Assuming the pressure of the supply to be constant and, for the moment, also assuming E T to be constant, an increase in working current can be brought about only by a proportional decrease of E B. Now, E B is proportional to the magnitude of the motor field, and also to the speed; the motor field being taken as constant, it follows that the speed alone must decrease in order to allow the required working current to flow. The required decrease in speed will be the greater, the greater the resistance of the rotor winding. In reality the conditions are, however, materially different. Our assumption of a constant motor field was made only in order to gain a preliminary and rough insight into the somewhat complicated and cumulative actions which do take place, and which bring about that characteristic and very abrupt falling off in the speed of an overloaded single-phase induction motor usually referred to as "falling out of step."

Even with constant line pressure the transformer field does not remain constant. As the C^2 R loss increases in the stator, so this field decreases in magnitude. The speed is not directly influenced thereby, but it suffers indirectly. A reduction of the strength of the transformer field brings about a corresponding reduction in the motor field, since the latter depends on the former for its magnitude. With the reduction of the motor field also goes a proportional reduction of E B, since this E.M.F. is directly dependent on that field for its magnitude; a reduction of the transformer field also brings about a proportional reduction of E T, but, as E B and E T are evidently both reduced in the same proportion, there is so far no need for the speed to alter. For a given torque, however, it is the product of motor-field strength into working current which is of moment, and since the field has been reduced, the working current must be increased in order to keep the torque constant. Since this can only be brought about by a reduction of speed, the latter must decrease. Every decrease in speed must be followed by a decrease in the strength of the motor field, for the latter is directly dependent on the speed for its magnitude; this necessitates a further increase in the armature or working current (axis C C) in order to keep the torque constant. This increase may be wholly brought about by the decrease of E B with the decrease of the motor field and the reduction in speed which has already taken place, or it may necessitate a further decrease in speed with all its attendant evils. Over and above these unfortunate conditions we must consider the increase of E S with increasing rotor current; the larger E S the greater will become the phase difference between the working current and the motor field; in consequence, a greater working current will be necessary in order to produce the required torque, even if the motor field were not subject to further alteration. Since, however, this greater working current can only be obtained by a reduction of the speed, and since such *must* again be followed by a reduction of the field strength, the conditions may truly be termed cumulative and fully explain why a single-phase motor falls off so abruptly.

The author thinks that his theory not only affords the most complete explanation of the behaviour of single-phase induction motors in all possible cases, but also indicates a very simple way of predetermining their operation by calculation. The whole theory is in reality so simple that it was thought possible to do it full justice without the use of formulæ or diagrams; all the data for the latter are, however, set out in full, so that they can be easily constructed. As to the formulæ necessary for the calculation, they are only adaptations of those already well known in connection with less complicated apparatus. It is seen that there is no need whatever to refer to the theory of the rotary field in order to explain the action of these motors. Indeed, that theory is not at all applicable to this class of motor, for, although two fields differing in phase and produced by currents differing in phase are involved, there is no reciprocal action between the two phases; and, as has already been pointed out, although such motors could be operated from a two-phase supply, the loads on the two phases would be totally unequal. That being so, it might well be asked why it is that such a motor runs at a synchronous or very nearly synchronous speed, just as a rotary field motor, and why it

is that the speed of such a motor cannot be varied independently of periodicity and the number of poles, the more particularly since its similarity and almost identity with the continuous current shunt motor have been so much insisted upon.

This query can be answered shortly by saying that the motors now known as single-phase induction motors are indeed shunt motors, in the usual acceptance of the term; and that what the author would like to term the natural speed of the particular construction now adopted happens to be a nearly synchronous one; further, that there is no reason whatever why an alternate current motor of the induction type, and having a shunt characteristic, should not be designed to run at any desired speed independently of periodicity and number of poles. Before showing how such motors can be designed to run at constant speeds differing from the synchronous, it will be well to ascertain why the natural speed of the more general constructions happens to be a nearly synchronous speed.

Pursuing our comparison of the single-phase induction motor with the continuous current shunt motor, and referring, as the most general example, to the disposition shown in fig. 1 (which has been shown to be the equivalent of a squirrel-cage rotor) we can at once say that the motor will reach its constant speed when the back E.M.F. (E B) practically equals the E.M.F. impressed on the armature brushes (E T). We will assume that the dispositions of the magnetic and electric circuits are really identical with the usual practice; namely, that both stator and rotor are entirely symmetrical in all directions, and that all windings embrace the same iron cross-sections.

We know that the magnitude of E T depends on the magnitude and on the periodicity of the transformer field, and has to be practically equalled (and opposed) by E B. Now E B must be produced in the same winding as E T, but by the motor and not by the transformer field. The rotor winding is placed in precisely the same inductive relation to both fields, therefore in the formula determining the magnitude of the E.M.F. induced in that winding by either field (E = c T.N.M) the coefficient C will be the same, the number of turns in series T will be the same; we know that both fields are of the same periodicity N, and if we assume for the moment that both are of the same magnitude, namely, that the number of C.G.S. lines M included or excluded by each turn in each axis in one magnetic cycle is the same, then both voltages will be equal, but they will be produced along axes coinciding with those of their respective fields and therefore perpendicular to each other. The back E.M.F. is, however, to be produced along the same axis as E T by rotation in the motor field and not by induction therefrom. When the motor is standing still E B will be zero, and the question is, at what speed must the rotor revolve in order to show along the axis C C an E.M.F. equal to E T. Still keeping to the assumption that both fields are equal in magnitude, and remembering that the inductive relations along both axes are identical, the condition of equality between E B and E T will evidently be fulfilled when the number of revolutions is such that the number of C.G.S. lines included or excluded by each turn in one magnetic cycle is the same as before; this happens when the speed is equal to the synchronous speed as determined by the periodicity of the transformer field and the number of poles of the motor.

The motor will therefore run nearly synchronously when the motor field equals the transformer field in magnitude. We have seen that in a given winding the E.M.F. produced by synchronous rotation in a given field is equal to the E.M.F. produced in the same winding by the same field, but by static induction; it is therefore clear that for the disposition in fig. 1 the E.M.F. produced by synchronous rotation of the rotor conductors in the transformer field will yield in the axis DD an E.M.F. of equal magnitude to E T, and seeing that the number of turns and the iron cross-section they enclose along this axis are the same as the number of turns and the iron cross-section along C C, the field set up by E R will be, at that particular speed, the same as that responsible for E T. For the sake of convenience, the author would like to refer to the conditions just set forth as the natural conditions, and to the speed they determine as the natural (or synchronous) speed.

(To be continued.)

PROCEEDINGS OF INSTITUTIONS.

The Measurement of High Frequency Currents and Electric Waves.

By Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

(Abstract of Cantor Lectures delivered before the Society of Arts; *concluded from page* 236.)

Stationary Electric Waves on Wires.

In acoustics we are not only familiar with progressive waves travelling through space, but also with so-called stationary waves in pipes or on strings. In the case of an organ pipe there is a variation of pressure and velocity from point to point in the pipe, and in the case of vibrating violin strings there are portions of string in strong movement and portions which are nearly at rest. By properly damping the string with the finger the violinist can cause it to sound not only the fundamental note of the string but also a higher harmonic.

Consider, then, in the first place, a very long wire immersed in an insulator; it has a certain capacity and inductance per unit of length, and also a certain wire resistance and dielectric conductance per unit of length. We can easily write down certain mathematical equations which express this fact symbolically. These equations also tell us that the voltage of the current does not instantly appear at all parts of the wire, but that if an alternating electromotive force is applied at one place, the potential and current are propagated along the wire with a velocity measured by $1/\sqrt{C L}$, where C and L denote the capacity and inductance per unit of length of the wire. Also the amplitude of the current and potential is weakened as we pass along the wire, in a ratio depending on R and K, the resistance of the wire and the conductance of the dielectric per unit of length of the wire.

In the next place, suppose that the cable is finite in length, the result then is that the wave of potential or current is reflected at the open end, and by interference with the direct wave produces standing waves of potential, just as when a rope fixed at one end is appropriately jerked at the other. In order that these standing waves may be produced, it is necessary, however, that the length of

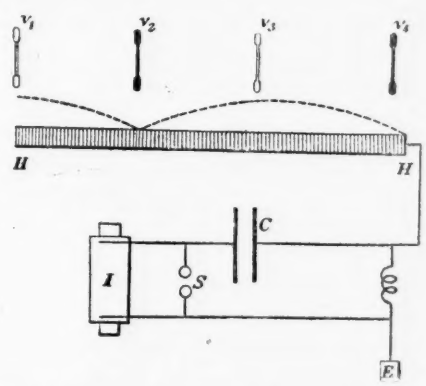

Fig. 13.—Stationary Waves of Electric Potential Established on a Helix by Direct Coupling.

the finite wire shall bear a certain relation to the wave length of the potential wave on the wire. The wave length and frequency are given by the well-known formula, *wave velocity = wave length × frequency*. Hence, since the wave velocity along the cable is $1/\sqrt{C L}$, if λ denotes the wave length and n denotes the frequency, we must have the following relation:—

$$\frac{1}{\sqrt{C L}} = n \lambda.$$

Suppose, then, that we apply to the end of the cable or wire a high-frequency electromotive force with a frequency n; we can do this by connecting the end of the wire to a condenser circuit having a capacity C^1, an inductance L^1, so that the frequency n is defined by the equation—

$$n = \frac{1}{2 \pi \sqrt{C^1 L^1}}.$$

Then it follows that the wave length on the wire of which the capacity per unit of length is denoted by C, and the inductance per unit of length by L, is given by the equation—

$$\lambda = 2 \pi \frac{\sqrt{C^1 L^1}}{\sqrt{C L}}.$$

Suppose, then, that the wire is cut of such a length l, that l bears the following relation to λ—

$$l = \frac{\lambda}{4} = \frac{3 \lambda}{4} = \frac{5 \lambda}{4} \&c.,$$

we shall have stationary waves produced on the wire.

It is very difficult to show this experiment with a straight wire, because, for any frequency which we can command, we need a wire of such an enormous length, since the potential and current travel along the straight wire with the speed of light; but if we wind a fine silk-covered copper wire in one layer of closely adjacent turns on an ebonite or glass tube, we can make a helix or conductor which has large inductance per unit of length, and hence, comparatively speaking, a small velocity of propagation. It is quite easy to make such a helix, on which the velocity of propagation is only $\frac{1}{10}$th part of the velocity of light.

This variation of potential is best shown by means of a neon vacuum tube which is held near the helix and moved about in the space around. It shows us the distribution of potential by the variation in its glow. We can then vary the frequency of the oscillations in the condenser circuit, so as to make the corresponding wave length on the helix respectively equal to 4 *l*/3, 4 *l*/5, 4 *l*/7, &c., and under these circumstances we find that there are nodes and loops of potential created upon the helix. When the neon tube is held near a node it does not glow, but when it is held near a loop of potential it glows brightly and we can create on the helix stationary electric waves having one loop of potential, two loops, three loops, &c.

Table V.

Observations made with a Helix of Wire wound on an Ebonite Core, and with an Ebonite Condenser, variable Inductance, and Neon vacuum tube to Determine the Wave-velocity along the Helix.

Oscillation.	Capacity in mfd. in condenser circuit. C.	Inductance in cm. in condenser circuit. L.	Calculated frequency. *n*.	Observed wave-length in cm. λ	Calculated wave-velocity. $w = n\lambda$ in cm./sec.
Fundamental	0·005835	110,000	$0{\cdot}197\times10^6$	(871)	(172×10^6)
1st harmonic...	0·002887	35,000	0·588 ,,	292	172 ,,
2nd ,, ...	0·001461	18,000	0·977 ,,	175	172 ,,
3rd ,, ...	0·001464	9,000	1·379 ,,	124	171 ,,
4th ,, ...	0·001461	6,000	1·70 ,,	95	163 ,,
5th ,, ...	0·001461	5,000	1·9 ,,	80	152 ,,

From the above table it is seen that the wave-lengths of the first, second and third harmonics are very nearly in the ratio of 3 : 5 : 7, for 292 × 3 = 876, 175 × 5 = 875, and 124 × 7 = 868. Hence, the fundamental wave-length should be 871. If we insert the value in Table V., and calculate the wave-velocity for the fundamental frequency, we find it to be 172 × 10^6 cm. per second, or exactly the same value as that obtained for the three succeeding harmonics.

Hence, from the fundamental and the three succeeding higher harmonics, we obtain values for the wave-velocity which are closely identical, and equal to 172 × 10^6 cm./sec., and in very near agreement with the velocity of 174 × 10^6 cm./sec. calculated from the constants of the helix itself.

There is a slight falling-off in the velocity obtained from the fourth and fifth harmonics, but the difficulty of measuring the small inductance then used in the condenser circuit is considerable.

Suppose that we have a wireless telegraph transmitter and we desire to know the wave-length radiated from the antenna, we can do it in the following manner. Let a long helix, made as described, be connected through a small condenser with the antenna and let a metal saddle slide on the helix, the said metal saddle being connected by a flexible wire with the earth (see fig. 14). We can then adjust the position of this saddle so that, by means of a neon tube, we have one complete stationary wave, as indicated by the dotted line set upon the helix. We can measure the length of this wave and, knowing the velocity of propagation along the helix, we can calculate the frequency of the oscillations. But this frequency must be the same as that of the oscillations in the antenna, and since the wave length of the wave radiated from the antenna is numerically equal to the quotient of the velocity of light, divided by the frequency, we obtain in this manner the measure of the wave length of the radiated wave.

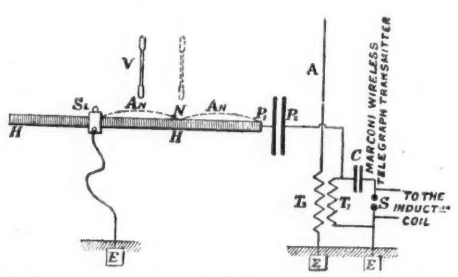

Fig. 14.—Use of a Long Helix as a Cymometer for Measuring the Wave Length of a Wireless Telegraph Transmitter.

It will be seen, therefore, that there are two classes of cymometers or wave meters for measuring long electric waves. First, the open circuit, or helix type, and second, the closed circuit. One of my own cymometers which I have described, and also that of Prof. Slaby, are of the open circuit type, and my other form of cymometer and that of Dönitz, are of the closed circuit type.

In using any form of cymometer it is essential that we should not alter the quantity we are trying to measure; thus, in using a closed circuit cymometer which is coupled inductively to an antenna, the coupling must be very loose, that is to say, the mutual inductance between the antenna and the cymometer must be small, or else each oscillation in the antenna will give rise to two oscillations of different period in the cymometer, neither of which is that of the antenna, which we are desirous of measuring.

Similarly, in using an open circuit cymometer we have to avoid producing a change in the capacity of the aerial by an earthed conductor held near it, and so altering its natural time period.

It is easy to avoid the above-mentioned errors with a closed circuit cymometer when using a sensitive detector, such as the neon tube I employ with my form of cymometer.

It has generally been assumed that when oscillations are set up in an insulated linear conductor of the Hertzian type the wave length corresponding to the fundamental oscillation is twice the length of the wire, but it has been shown mathematically by Mr. H. M. Macdonald in his book on "Electric Waves," that the length of waves is really 2·53 times the length of the linear oscillator, and this fact has been experimentally confirmed by Prof. Pollock and others.

In experiments with helices I have always found that the distance from the open end of the helix to the first potential node is much less than a quarter of the wave length on the helix, that is to say, is less than half the distance between the two next nodes. Thus reverting to the helix of which data have been given, the diagram in fig. 15 shows the distribution of the nodes of potential on the helix for the different harmonics used, and we see that the distance from the end of the helix to the first node is always less than half the distance between the two nodes.

Theory shows that the distance between the first and second nodes is always exactly or very nearly half the wave length, hence it follows that when we set up the fundamental oscillation on a helix by coupling it directly at one end to an oscillation circuit, the length of the stationary wave established on the helix is more than four times the length of the helix.

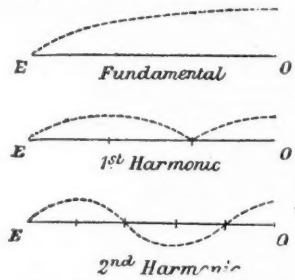

Fig. 15.—Stationary Waves of Potential on a Wire.

From experiments made with the cymometer I have ascertained that when using the ordinary forms of oscillation transformer used in wireless telegraphy, the relation between the length of the wave radiated from the antenna to the length *l* of the wire forming the antenna itself and the length *l'* of the wire forming the secondary circuit of the oscillation transformer in series with the antenna, is given by an empirical formula of the form—

$$\lambda = 5\ (l + m\ l'),$$

where m is some number lying between 2 and 5.

The only satisfactory method, however, of measuring the length of the radiated wave is to measure, as described above, the frequency of the oscillation in the antenna by means of the cymometer.

In practical wireless telegraphy, when using oscillation transformers with a coupling coefficient lying between 0·4 and 0·6, one radiated wave may have from 20 to 50 per cent. greater wave length than the other, and the lengths of these radiated waves are connected with the natural free frequency *n* of the antenna by the formula.

In conclusion, I may indicate a few outstanding problems in connection with the measurement of long electric waves which have not yet received complete solution. We have much need of a more simple quantitative wave detector which will provide means for determining the maximum intensity and damping of the waves impinging on a receiving aerial. In the matter of transmitters, the objections to the use of a spark gap are many and serious. It will no doubt be found possible at some time to solve the important practical problem of producing continuous trains of electric waves of known or regulated amplitude. When this is done many other problems will receive solution. The important practical problem of locating the radiant point has attracted many inventors, and it is possible that before long a solution may be arrived at.

Modern Electrical Developments.

At a recent meeting of the Manchester Association of Engineers, Mr. G. F. Metzger, M.I.C.E., M.I.E.E., read a paper on this subject. With regard to central stations, he said that every scheme must necessarily be considered on its own merits. Statistics were of no great value, as no two stations ran on exactly equal bases. They became still more misleading when low works costs, sometimes boasted of, were partly obtained by the salaries of those responsible for extensions or new work being placed to capital account (a thing not permitted in municipal undertakings), or where unpaid

premium pupils, or men on small wage, were entrusted with posts in works which should be held by qualified, and, therefore, properly-paid, officials. These and similar methods must necessarily be adopted in the smaller stations if works costs were to be kept low to prevent a call on the rates. When this was the case, the ownership of such stations ought never to have been entrusted to municipalities, but they were nowadays so eager to prevent private capitalists entering what they considered their sphere of operations, that local authorities applied for provisional orders for working their own electricity undertakings, even when a power company was on the spot and ready to supply energy at a cheaper rate than they could produce it at themselves. Thus what was considered municipal enterprise, frequently ended in financial disaster. If schemes presented to the Local Government Board for approval were first examined and criticised by engineers with central station and tramway experience, the present unsatisfactory state of affairs in most municipal electrical undertakings would not exist.

Ignoring the less important ones, there were 184 undertakings in Great Britain and Ireland, the total capital expenditure on which amounted approximately to 28 millions sterling, 10 millions of which were absorbed by the 10 largest, and a further three millions by the second 10 most important undertakings, the remainder, or 15 million pounds, had been spent by 164 municipalities, or, roughly, £90,000 by each, on the average.

Municipal Electrical Undertakings.

Town.	Capital.	Gross profits.	Street lighting.		Motors.	Traction.
	£	£	Arcs.	Inc.	H.P	H.P.
Manchester ...	2,199,690	166,207	53	—	11,000	11,068
Liverpool ...	1,718,713	136,490	189	28	5,190	9,000
Glasgow ...	1,119,048	99,879	814	—	6,500	—
Edinburgh ...	845,337	72,658	998	13	5,340	—
Leeds ...	817,304	56,790	247	—	3,900	—
Sheffield ...	804,527	42,982	—	—	3,600	—
Birmingham...	665,424	39,573	—	—	1,770	—
Salford ...	546,977	40,692	116	—	3,000	11,000
Brighton ...	522,437	38,335	372	3,260	1,080	2,400
St. Pancras ...	460,366	40,316	461	—	315	—
Total of 10	£9,699,825	£733,922	—	—	—	—
Bristol ...	542,244	31,531	677	8	3,000	—
Nottingham ...	417,272	37,226	160	—	2,000	2,100
Hampstead ...	346,608	29,115	122	41	400	—
Sunderland ...	304,665	10,434	165	48	5,470	3,250
Hull	302,933	22,700	20	42	2,700	—
Hackney ...	273,897	20,224	293	—	986	—
Croydon ...	271,258	20,933	410	87	300	4,200
Norwich ...	261,548	20,141	16	9	1,104	—
Bolton ...	256,821	24,138	8	—	2,800	1,500
Leicester ...	245,131	19,884	—	—	700	3,000
Total of 20	£12,922,202	£979,248	—	—	—	—

As the total gross profit on the whole 184 undertakings for the last year's working was £1,127,000, and two-thirds of this was credited to the ten largest, and a total of one million to the first 20 concerns, the remaining £127,000 was left to be divided amongst 164 undertakings on their 15 millions of capital, or a return of less than 1 per cent. But of these, 69 undertakings, representing five millions of capital expenditure, showed a net annual loss of £70,000 after having provided in most cases for interest on loans and sinking fund out of their gross profits. But only in rare instances was a depreciation fund established, and this, when it existed, was not proportionate either with the capital expended or the life of the plant. Comparing these figures with electrical enterprise as carried out by public companies, of which there were 60, with a total capital expenditure of 17 millions, the gross profit was given as two millions, or 11¾ per cent. All but three of these companies, with a total deficit of £310, representing a capital expenditure of only £53,000, showed a net profit on the year's working; whilst, in addition to substantial dividends paid to shareholders, large depreciation and reserve funds were being built up. This was done in spite of the fact that municipalities had the enormous advantage of the load and revenue derived from street lighting, which in many towns was one of the most money-earning branches of municipal undertakings, and accounted for their comparatively favourable balance-sheets. In some cases private companies were entrusted with the supply of energy for public lighting also, but not nearly to the extent of municipalities. In addition, 78 towns provided the energy for tramways from their municipal electric light works, whilst only nine private companies benefited in a similar way.

Manchester held the record amongst municipalities in respect of its motor and tramway load. This accounted for its showing the largest gross profits of any electricity undertaking in the country. Last year's return showed:—

Class of load.	Units sold.	Revenue.
Private lighting	9,939,381	£159,300
Public ,, ...	81,032	675
Motors	4,739,992	23,260
Tramways	18,926,305	117,590
	33,686,710	£300,825

These figures proved the importance of both tramway and motor loads, which had raised the Manchester Corporation electricity undertaking to the premier position in this country as regarded output and revenue. If the original scheme, which provided for electrically lighting 80 miles of main tramway-served thoroughfares were carried out, about 4,000 arc lamps would be required.

Mr. Metzger spoke of the modern development of electric motors, and pointed out the conditions necessary to the successful working of these. He also discussed street lighting problems. Electric tramways, he said—of which 1,800 miles now existed in the United Kingdom—had probably made greater progress than any other branch of electrical engineering. Our Board of Trade restrictions, however, or the petty jealousies of local authorities, prevented the progress which had been realised by foreign countries. Tramways should not only serve townships and outside rural districts many miles from the source of supply; the various lines belonging to many districts, whether they were controlled by local authorities or private syndicates, should be linked together in such a way that it would be possible to travel almost from one end of the country to the other. Long-distance services were making considerable progress in England. Since the day when the single reduction traction motor, the series-parallel controller and the overhead trolley were adopted in England, as standards of tramway practice, practically no improvement had been made until quite recently in equipments, except in the simplest details. The tramway world had now before it the automatic regeneration system, the main principle of which was the use of a shunt-wound motor, instead of a series motor, it being well known that such motors would act as regenerators when their back electromotive force exceeded the electromotive force of the line. It was impossible to use shunt motors for electric traction until they were so far improved as to have a fixed line of commutation, and very great difficulties had to be overcome in adapting both the motor and the controller to the existing conditions of electric traction. The first attempts were made with motors coupled permanently in series, which, however, reduced the speed up severe gradients. The development of a series-parallel controller and the addition of a few turns of series winding, to the shunt winding, of the motors had removed this objection, whilst the tractive effort and, consequently, the accelerative power were not diminished in any degree, but on the contrary, somewhat enhanced. The principal advantages of this method of control were:—

1. A car had the full power behind it, even when travelling at very slow speeds.
2. The braking effect was superior to that obtained with any other arrangement.
3. The saving of electrical energy, which varied according to the nature of the road from 10 per cent. on dead level line to 35 per cent. on a hilly line.
4. The reduction in the wear and tear of the brakes, wheels and rails.

The last item deserved the serious attention of tramway undertakings, as the question of allowing an adequate amount for depreciation on these items did not appear to have been given sufficient consideration when dealing with the annual balance-sheet.

Speaking of the rise of power supply companies as an important development, Mr. Metzger said that many urban authorities were wisely handing over their concessions to such companies, and so relieving themselves of the responsibility of installing their own generating stations, and obtaining their energy in bulk at wholesale price. They only had to distribute their electricity, and as this could be done, owing to the low initial price charged them, at a profitable figure, the return on the capital expended on cables and meters was ensured. Even if mills, mines and factories were able to generate their own supply (not having to provide the distribution expenses of a power company) at a slightly lower figure, the convenience of always having the power at command for light and heavy loads, without having to meet capital expenditure for engines, boilers and the buildings to house them, was recognised by the owners.

The Rectification of Alternating Currents.

By P. Rosling, Member.

(*Abstract of Paper read before the* Institution of Electrical Engineers *at Leeds, January 18th*, 1906.)

For small powers there are now two systems of rectification in commercial operation, both of them having the supreme advantage of having no moving parts—viz., the electrolytic rectifier and the mercury arc rectifier.

The electrolytic rectifier consists of plates of an alloy mainly composed of aluminium, acting as cathode, suspended in a solution of borate or phosphate of ammonium or other salt capable of rapidly altering the condition of the polarising layer or film formed on the passage of an alternating current, such as salts of tartaric, oxalic, acetic or gallic acids. The electrolyte may be contained in lead cells, which would then form the anode.

When a single-phase alternating current is switched on to such a combination, if the direction is positive from the lead to the aluminium, it passes on through the circuit; if, however, the direction is positive from the aluminium to the lead, a polarising insulating film is immediately formed on the lead, which offers a high resistance and opposes the passage of the current. When the polarity reverses, and the current flows from the lead to the aluminium plate, the film undergoes alteration, and the current passes readily. If only one semi-phase is required, a single cell is

In using any form of cymometer it is essential that we should

for extensions of new work being placed to capital account (a thing not permitted in municipal undertakings), or where unpaid

sufficient, giving an interrupted unidirectional current of the periodicity of the alternating current.

In usual practice both semi-phases are used, either by grouping four cells, as in the Leo Gratz method, so that they allow the current to pass through two cells in series, turn and turn about, as shown in fig. 1, or as in the Churcher method, where one platinum or lead plate and two aluminium plates are suspended in one cell, the current coming through the working circuit from the middle point of a reactance coil (fig. 2).

In fig. 1 the path of the current during one semi-cycle is shown by the arrows. It passes through cell v″, the accumulator and v‴, the insulating film forming on v′, the aluminium to lead path, preventing the current short-circuiting across to the other side of the A.C. circuit. On the reversal of the polarity the current flows

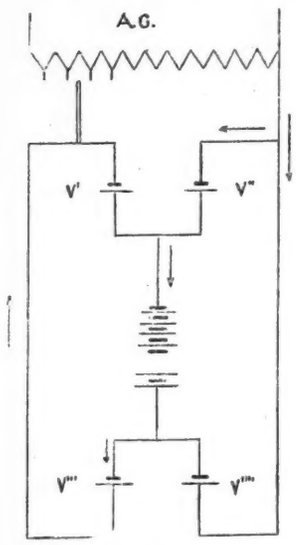

Fig. 1.

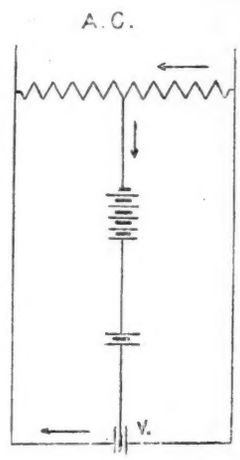

Fig. 2.

through v′, the accumulator and v‴″, v″ now forming the "closed door." The current thus passes in the same direction through the accumulator in pulsations of twice the periodicity of the alternating-current circuit.

Fig. 2 shows the Churcher arrangement. The path during one semi-cycle is shown by arrows: from the middle point of the reactance coil through the accumulators and the rectifier cell v. On reversal of polarity, the current flows through the other half of the reactance coil, the accumulators and the other half of the cell v.

In both systems the reactance coil can be arranged with multiple tappings, so that the correct electromotive force for the work to be done can be efficiently obtained, the pressure across the direct-current circuit being approximately 90 per cent. of the pressure between the tapping and the terminal end of the reactance coil.

Rectifiers of this description may be used on 50 to 100-cycle circuits where the A.C. pressure does not exceed 140 to 150 volts, and where the temperature of the electrolyte can be kept below 120° F.; above this temperature the efficiency falls off very rapidly.

In a test made by Mr. Horace Boot* of an electrolytic rectifier arranged as in fig. 1, and known as the Nodon valve, an overall efficiency of 65 per cent. was obtained on apparatus-charging cells (50 amperes × 118 volts). This result compares favourably with a motor-generator of similar capacity, which, over the whole run, would not give more than about 55 per cent. efficiency.

It is usual to insert a resistance between an electrolytic rectifier and the alternating current circuit, otherwise it sometimes happens that there is a large rush of current on first starting, especially if the plates have been left in the electrolyte; this resistance can be short-circuited when the apparatus has started working.

The loss in an electrolytic rectifier is principally leakage current, which does not pass through the direct current or load circuit, but is expended on heating the electrolyte and is dependent upon the electrode potential at the film, the quality of the aluminium electrode and the particular electrolyte used, and as the losses increase enormously if the temperature of the electrolyte exceeds 120° F., it is necessary to provide some means, such as cooling tubes or forced ventilation, to keep the apparatus below that temperature.

In the above test there was a drop of 8 volts on the cells, or 4 volts per cell, and a loss of 22 amperes out of 72 in the four cells.

The Mercury Arc Rectifier.—The mercury arc rectifier, for a single-phase circuit, is an exhausted glass vessel containing two anodes A A, one cathode B, and one starting anode C, fig. 3.†

The two anodes are connected across the terminals of the alternating current line and become alternately positive and negative. While either anode is positive there is an arc carrying the current between it and the cathode. When the polarity reverses, the arc passes from the other anode to the cathode, so that, during a complete cycle, the cathode is negative and the current at this point is unidirectional, and both semi-cycles of the alternating current are used. The cathode of the rectifier is connected to the load or working circuit, the other pole of which is connected to the middle point of a reactance coil, which is connected across the alternating current circuit.

Without some means of continuing the arc, or establishing it at every reversal of polarity, the rectifier would not work, as the arc would stop at every reversal of the alternating current; although the current is at zero for an infinitesimally short time, yet this interval, even on a high periodicity circuit, is sufficient for the cathode to lose its excitation and the arc to go out.

The reactance coil is therefore so arranged that the current is held over the zero value and the pulsations are smoothed out, the current at the cathode becoming not only unidirectional but a true direct current with pulsations of small amplitude.

The initial ionisation of the mercury vapour is accomplished by a small starting anode C, fig. 3, which is brought into contact with the cathode by a mercury bridge formed by slightly shaking the tube. The breaking of this mercury bridge starts a small initial arc, and the arc thus obtained excites the cathode, giving the necessary ionised vapours, which enables the working anodes immediately to become active and the tube to start.

Fig. 3 shows the connections of a rectifier diagrammatically, the plain arrows marking the path of the current at any moment, and the arrows in circles showing the path on the reversal of polarity.

It will be seen that the circuit from the alternating current terminals is composed of a rectifier arc, the load and one of the reactance coils; the other coil is at the same time discharging energy stored up during the previous half-wave, when it was in the line circuit.

The amount of reactance inserted in the circuit reduces the pulsations of the direct-current sufficiently for all ordinary commercial purposes, but when it is advisable still further to reduce the amplitude of the pulsations, more reactance can be used, with a very slight reduction in the efficiency; with a suitable reactance the pulsations can be so reduced that the rectifier can be used floating on a battery for telephone work, giving no appreciable hum.

With a pure resistance load, it is only necessary to have sufficient to keep current flowing when the alternating potential falls below 14 volts, the voltage required for the mercury arc, whereas, when charging accumulators, sufficient reactance is required to keep the arc when the alternating-current drops below the back electromotive force of the cells, plus the 14 volts for the arc, and, as the alternating-current voltage should not be much higher than the cell voltage, the reactance coil has to keep the current flowing through quite a considerable proportion of the cycle.

Mercury arc rectifiers can be used on any practical voltage; the maximum voltage is at present unknown, as with a rectifier of proper design and vacuum, a high frequency oscillator giving an 8 in. spark between 1 in. spheres does not send a discharge through from anode to anode; small currents at 36,000 volts impressed upon the

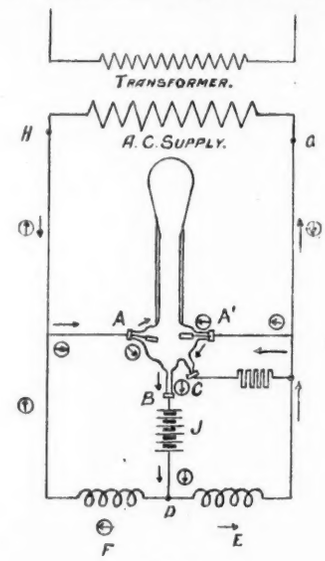

Fig. 3.

rectifier terminals have been rectified successfully, and a rectifier tube with 24,300 volts at its anodes and 6·25 amperes at 9,500 volts continuous current at the cathode, has been successfully used on a water resistance—that is, a load of about 60 KW. has been rectified in a tube weighing a few pounds.

A high-tension rectifier is now in general use in Schenectady, supplying 57 series arc lamps, giving 4 amperes at 4,260 volts continuous current, having an overall efficiency of over 90 per cent., including losses in the alternating constant-current transformer and the reactance coils used to carry the arc over from one semi-phase to the next, and special reactance coils in the continuous-current circuit used to reduce the pulsations of the current, the loss in rectifier itself being about ·4 per cent.

* Electrical Review, February 10th, 1905, p. 211.

† For full description see Electrical Review, November 24th, 1905, p. 864.

For ordinary commercial work off supply mains the rectifier can be designed for any standard pressure or frequency; the maximum continuous current pressure is approximately half the alternating-current voltage, and the continuous current nearly double the alternating current, the ratios being varied by means of suitable tappings from the reactance coil.

As the loss in the arc is constant, the efficiency, of course, varies with the direct-current pressure delivered; thus, on a test of a 30-ampere set giving 80 volts on the continuous current side and working on a 220-volt alternating circuit, the overall efficiency was 75 per cent., but with 112 volts on the D.C. side the efficiency was over 80 per cent. This efficiency holds good down to quarter load, the power factor of such a set being practically 90 per cent.

To charge a battery so that the maximum battery efficiency can be obtained, comparing the watt input and output, it is necessary to reduce the rate of charge as the operation proceeds, so that with a motor-generator starting at 30 amperes and an overall efficiency of about 65 per cent., the motor-generator efficiency falls off as the charge continues until it approaches the neighbourhood of 30 per cent., giving an average efficiency throughout the whole charge of, say, 55 per cent.; comparing the cost of running a mercury arc rectifier on cells taking 15 units in a five-hours' charge at about 110 volts, with the running cost of a motor-generator, the saving would be approximately 8¼ units, or, at 2d. a unit, 1s. 5d. per charge; and, as there is no part of the apparatus likely to wear out, other than the tube itself, there is nothing to set off against this saving, and, should the tubes last, say, 1,000 hours (and some have been tested to 1,500 and 2,000 hours), the saving in current during the life of the tube would amount to £10 3s. 4d., or 30 per cent. of the current bill for the motor-generator set for the same work. Comparing it with an electrolytic rectifier of 65 per cent. efficiency, the saving on 200 charges of five hours each would be £7 1s. 8d., at 2d. per unit.

For charging cells the mercury arc rectifier has a certain inherent regulation similar to a shunt-wound dynamo, the voltage at the cathode rising as the current falls, thus tending to compensate for the increase of the counter E.M.F. of the battery, so that the regulating switch need not be moved very frequently during the charge; the regulating switch being connected to the reactance coil, the efficiency of the apparatus is practically constant throughout the charge.

Three-phase current may be rectified into continuous current by means of tubes having three anodes, the load being connected between the cathode and the neutral point of a three-phase star-connected reactance coil, and, as with a three-phase current, there is no zero point, the continuous current has less pronounced pulsations, with the same amount of reactance, than with the single-phase system, as shown above with the electrolytic rectifier.

Mr. WILKINSON said that he got an electrolytic rectifier of large size from Paris about three years ago. In order to give it a fair trial it was set to supply current to a motor driving stoker shafting, running 24 hours per day for six days per week. The result was very unsatisfactory. This was a rectifier of French design, and it was kept cool by an electric fan placed beneath the rectifier. He understood that some progress had been made in the direction of making them more reliable. The efficiency obtained from the apparatus was about 60 per cent. He had had a considerable amount of experience in making mercury vapour lamps, and one thing that troubled him was that after running the early lamps for a short time the vacuum was lost, viz., in lamps taking the small current of half an ampere. After a considerable time he found that it was necessary to seal two or three small platinum wires in the glass rather than one larger one, in order that the good vacuum might be maintained. This pointed to a practical difficulty in these rectifiers when designed for heavy currents. An apparatus giving the small current of 4 amperes at 4,260 volts, would be very little use in many of our supply stations. The rectifier, giving 80 volts and 30 amperes, would be useful for charging automobiles, but what was really wanted was one giving two or three hundred amperes, and, say, from 200 to 300 volts, which could be used for charging batteries on a large scale. The efficiency was exceedingly good, and surpassed that of small motor-generators. He asked whether there was any possibility of reversing the operation and taking out an alternating current when supplied by a direct continuous current on the direct current side?

Mr. CHURTON referred to the difference between the prime cost of the motor-generator and the Nodon valve, and that of the mercury vapour rectifier, the cost of running, the efficiency, and the cost of renewals and repairs. A motor-generator of only half a kilowatt for charging accumulators for ignition work had an overall efficiency of 69·5 per cent. In a large set it was quite easy to get a combined efficiency of 81 per cent., which was higher than anything obtained by the mercury rectifier.

Mr. G. D. ASPINALL PARR said the other type of rectifier which he had tested, was one in which there was a contact breaker, and the phase was split by means of a choking coil and a condenser. The efficiency of this apparatus was very low. The power factor commenced at ·8, but dropped immediately to ·47; the efficiency was 37 per cent., falling to 33 per cent. The machine worked very satisfactorily so far as sparking was concerned.

Mr. MOUNTAIN was of opinion that in working crane motors and for street lighting, it would be exceedingly useful if they could get a rectifier to convert alternating to direct current. He had been experimenting with mercury vapour lamps, and had no doubt that for street lighting they were going to put everything else out entirely for efficiency.

Mr. P. ROSLING, in reply, referring to Mr. Wilkinson's remarks, said he thought the stoker shafting running 24 hours a day was a very good test for any apparatus; the chief difficulty with electrolytic rectifiers had been that they were only serviceable for short runs, and if they were allowed to get hot, the potential resistance of the anode disappeared. He understood that the electrolytic rectifier now in the market was guaranteed for ordinary commercial purposes. Referring to the mercury rectifier, there was no trouble now in keeping the vacuum; but owing to other circumstances, one of which was the temperature of the anodes, rectifiers for an output of more than 30 amperes were not yet on the market. The 30-ampere size would be about £50, the 20-ampere size about £45, and the 10-ampere size about £38. As to the reverse operation of the rectifier to act as a converter, such a device had been developed. A tube such as shown in fig. 3 had four terminals as anodes and one terminal as cathode, placed centrally with reference to the four anodes; the diametrically opposite anodes were connected to the terminals of one primary, and the other anodes also opposite to one another and at 180° to the first pair, to the terminals of the other primary of a two-phase transformer; the middle points of the two primaries were connected together and to the positive terminal of a direct current source of energy; the cathode was connected through a reactance coil to the negative terminal of the supply. Directly an arc was established between the cathode and one of the anodes, the arc immediately jumped to a neighbouring anode and so on round the tube, with a rapidity depending to a considerable extent upon the size of the anodes and their distance from the cathode. As an arc was established, current flowed through one half of one of the primaries; an alternating magnetomotive force was thus produced by each primary winding, which generated in the corresponding secondary an alternating electromotive force, one revolution of the arc making two complete cycles in each secondary, and as the anodes were at 90° with one another, a regular two-phase current was obtained from the two secondaries. The shifting of the arc from one anode to its neighbour seemed to be due to the heat generated by the arc, causing the resistance to rise until a point was reached, when less resistance to current flow existed between the adjacent anode and the cathode; as this alteration of resistance would cause pulsation in the D.C. circuit, an inductance coil was used as a storing and restoring agent, rendering the flow of power in the direct-current circuit more steady. Any other number of phases might be obtained by a suitable combination of anodes and transformers. Replying to Mr. Churton, the figures given included the necessary switchboard and instruments; the running cost was less, and the rectifier in convenience far superior to the motor-generator. The efficiency of the arc-light generator included the losses in the constant-current transformer; the efficiency of the rectifier tube itself was 99·6 per cent., the only loss being the 14 volts drop across the arc. There had been no trouble with disintegration of the graphite anode in the mercury arc rectifier.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"H. B. M." writes:—"The treasurer of a certain Town Council, after making repeated applications for payment of an account from a consumer of electricity, finally gave notice that unless paid by 10 a.m. on a certain date the supply would be cut off. The official of the electricity department went at this time to disconnect the supply, but the consumer brought him back to the works, and there arranged that he would send payment to the electricity works by 4 p.m. The consumer paid at the treasurer's office at 3 p.m., and a clerk there promised to advise the electricity department that the accounts were paid, but, being very busy, omitted to do so. The supply was cut off at 5 p.m., as the consumer had not paid at the works as arranged.

"Is the Council liable in damages for cutting off supply after the accounts have been paid, notwithstanding the fact that the consumer was behind with his accounts, and have any similar cases ever been decided? Both the Council and the consumer are founding on Sec. 21 of the Act of 1882."

*** This is a question which, as "H. B. M." points out, depends on Sec. 21 of the Electric Lighting Act, 1882. By that section, if a consumer fail to pay for current supplied, he may be cut off. The question in the present case is, Were the electricity department entitled to cut him off? The department agreed to accept payment at the works and the consumer pays at the treasurer's office. In these circumstances it is thought that the fault was the fault of the consumer, who failed to carry out his arrangement. It is, however, a case of some hardship, and the department should make some reparation if any loss has been suffered by the consumer.

"READER" writes:—"Can a gas company or water company compel by Board of Trade rules or legal right that electric light cables shall be a certain distance from their pipes; if so, what is the distance? Can they compel a man-hole less than 6 ft. sq. to be ventilated; if so, what is the maximum that they have to be ventilated?"

*** As to the first half of "Reader's" question, it is clear that by Sec. 18 of the Electric Lighting Clauses Act, 1899, a gas company may compel an electric lighting company to place their lines within a reasonable distance of the gas pipes. As to street boxes, if they exceed 1 cb. yd. in capacity, ample provision must be made for their ventilation.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

24,009A. "Improvements in and relating to electrically controlled valve gear for motive-power engines." R. Kendal. (Date applied for under Rule 5 of the Patents Rules, 1905, September 7th, 1905.) January 31st. (Complete.)

2,174. "A system of electric alarm bells to indicate the opening of railway carriage doors while trains are in motion." J. S. Kingston. January 29th.

2,184. "Improvements in electric fuse boxes." S. L. Smith. January 29th.

2,185. "Electric controller for lifts, hoists and cranes." J. Mair. January 29th. (Complete.)

2,194. "Improvements in wireless telegraph systems." C. G. G. Brauner-hjelm. (Date applied for under Patents Act, 1901, February 3rd, 1905, being date of application in Sweden.) January 29th. (Complete.)

2,196. "Improvements in electric switches." H. E. Edwards. January 29th.

2,218. "Improvements in and relating to electricity meters and the like." The Bastian Meter Co., Ltd., G. Calvert and A. J. Abraham. January 30th.

2,236. "Improvements in shades for incandescent electric lamps." C. G. Redfern. (The firm of Heilbrun & Pinner, Germany.) January 29th.

2,244. "Improvements in the production of electric arc light and in apparatus therefor." P. M. Justice. (Phœnix Elektrotechnische G.m.b.H., Germany.) January 29th. (Complete.)

2,249. "Improvements connected with controlling devices for electric motors." R. A. Marples. January 29th.

2,259. "Improvements in and relating to electric arc lamps." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) January 29th.

2,285. "Improvements in electro-magnetic coils." S. A. Pollock. January 30th.

2,286. "Improvements in and connected with electric branch switches." J. B. Meiklejohn. January 30th.

2,317. "Improvements in machines for the electric welding of chains, rings, and the like." O. Kuppers. January 30th. (Complete.)

2,322. "Improvements in connection with shaft bearings particularly applicable for dynamo-electric machines." P. M. Justice. (The Bullock Electric Manufacturing Co., United States.) January 30th. (Complete.)

2,328. "Improvements in or relating to arc lamps." E. Cervenka. January 30th.

2,329. "Improvements in or relating to electrically propelled vehicles." M. Pfatischer. January 30th.

2,337. "A potential regulator for electric currents." K. Warming. (Date applied for under Patents Act, 1901, June 14th, 1905, being date of application in Denmark.) January 30th. (Complete.)

2,342. "Improvements in means for perforating paper slips for telegraphic signalling or other purposes." M. Kotyra. January 30th.

2,364. "Improvements connected with dynamo-electric machines and electric motors for maintaining a constant electromotive force under variations of speed." M. W. W. Mackie. January 30th.

2,367. "Improvements in or relating to single-phase alternate current motors and generators." V. A. Fynn. January 30th.

2,409. "Portable screw box and feed for electric drilling machine." P. F. Smith. January 31st.

2,426. Improvements in magnetic compasses and the like." W. T. St. Aubin. January 31st.

2,441. "Improvements in and relating to electric arc lamps." M. Graetz. January 31st. (Complete.)

2,452. "An improved telephone system." E. G. Hall. (Date applied for under Patents Act, 1901, February 8th, 1905, being date of application in United States.) January 31st. (Complete.)

2,456. "Improvements in the electrolytic production of copper wire strip or the like." S. O. Cowper-Coles. January 31st.

2,458. "Improvements in and relating to dynamo-electric machines for electrically-propelled vehicles." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 31st.

2,463. "Improvements in and relating to incandescent electric lamps." J. F. Duke and H. Hirst. January 31st.

2,465. "Improvements in electrolytic apparatus." E. Hermite. January 31st.

2,485. "Improvements in and relating to wireless telegraphy." A. W. Turner, H. J. Peers and H. J. W. Ridley. February 1st.

2,510. "Improvements in electrical measuring instruments." The British Westinghouse Electric and Manufacturing Co., Ltd. (J. Roberts, Natal, South Africa.) February 1st.

2,514. "A device for grinding the contact surface of carbon brushes for dynamos and the like." A. Watkins. February 1st.

2,547. "An improved system of electric ignition for gas and petrol engines." W. S. Frost. February 1st.

2,548. "Improvements in or relating to safety apparatus for overhead electric conductors." M. Letrotuer. (Date applied for under Patents Act, 1901, February 10th, 1905, being date of application in France.) February 1st. (Complete.)

2,552. "Improvements in electric furnaces." A. G. Betts. February 1st. (Complete.)

2,553. "Improvements in the economic production of mechanical energy for distribution by means of electricity, compressed air, hydraulic power or other agent." E. W. Tate and R. W. Weekes. February 1st.

2,554. "Improvements relating to the manufacture of filaments for electric incandescent lamps." H. Zerning. February 1st. (Complete.)

2,574. "Improvements connected with recording and indicating the use of and current used in electrical heaters and other electrical appliances." T. E. R. Phillips. February 2nd.

2,603. "Improvements in and relating to metallic vapour arc lamps." B. E. D. Kilburn. (Phönix Electro-Technische Ges.m.b.H., Germany.) February 2nd. (Complete.)

2,604. "Improvements relating to the speed regulation of single-phase commutator electric motors." B. G. Lamme. (Date applied for under Patents Act, 1901, February 6th, 1905, being date of application in United States.) February 2nd. (Complete.)

2,605. Improvements relating to the phase regulation of single-phase commutator electric motors operated from polyphase circuits." B. G. Lamme and C. Benshaw. (Date applied for under Patents Act, 1901, February 6th, 1905, being date of application in United States.) February 2nd. (Complete.)

2,629. "Improvements in and relating to controlling devices for electric motors." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) February 2nd.

2,631. "Improvements in and relating to electric resistances." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) February 2nd.

2,641. "An improved process and improvements in iron wire resistances." H. Beck and Physikalisch-technisches Laboratorium, G.m.b.H. (Date applied for under Patents Act, 1901, February 2nd, 1905, being date of application in Germany.) February 2nd. (Complete.)

2,669. "An improved spring drive suitable for steam, petrol, and electrically-propelled vehicles and other machines." C. B. Hannan. February 3rd.

2,687. "Improvements relating to electric ignition gear for explosion engines." A. Sharpe. February 3rd.

2,691. "Improvements in electric heating, cooking and smelting." W. Moseley. February 3rd.

2,705. "Improvements in commutation windings for direct current dynamo-electric machines." Siemens Bros. & Co., Ltd., J. C. Wilson and W. G. Griffith. February 3rd. (Complete.)

2,707. "An improvement relating to the introduction of electrical apparatus having magnetic cores or masses into alternating-current circuits." Siemens Bros. & Co., Ltd. (Siemens-Schuckertwerke G.m.b.H., Germany.) February 3rd. (Complete.)

2,709. "An improvement in or connected with public electric lighting systems." S. B. Apostoloff. February 3rd.

2,716. "Improvements in or relating to automatic starting devices for electric motors." A. J. Boult. (W. C. O'Brien, United States.) February 3rd. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

Mechanism for Imparting Varying Degrees of Longitudinal and Rotary Motion Applicable to a Pointer, Contact Arm or the like, for Use in Printing Telegraph Instruments, Automatic Telephone Switches, and for other Purposes. A. P. Hanson. (Date applied for under International Convention, October 1st, 1903.) 21,116. October 1st.

Method of Operating Telephonic Exchange Systems and Apparatus Therefor. A. T. M. Thomson and Thomson-Davis Telephone System, Ltd. 21,382. October 5th.

1905.

Telephone Call Registers. A. Meyer. 15,289. July 25th.

Conveying Currents to Electrodes Arranged in Electrically Insulated Tubes. Ganz & Co. Eisengiesserei und Maschinen Fabriks Act.-Ges. (Date applied for under International Convention, August 26th, 1904.) 15,594. July 29th.

Thermo-Electric Couples. British Thomson-Houston Co., Ltd. (General Electric Co.) 17,181. August 24th.

Dynamo-Electric Machines. Allgemeine Elektrizitäts-Ges. (Date applied for under International Convention, September 22nd, 1904.) 19,138. September 21st.

Constant Current Electric Distributing System for the Utilisation of Variable Sources of Power. O. Böhm. 19,201. September 22nd.

Apparatus for and Process of Electric Welding. W. L. Wise. (Thomson Electric Welding Co.) 123. January 3rd.

Electrolytic Meters. C. W. Atkinson. 3,431. February 18th.

Electric Potential Indicators. British Thomson-Houston Co., Ltd. (General Electric Co.) 3,815. February 23rd.

Electric Arc Lamps. H. E. Angold. 4,740. March 7th.

Process and Devices for Producing Heat and Ignition by Means of Catalytic Action. J. C. Voss and E. Stern. 6,730. March 30th.

Arc Lamps. J. M. Wellington and W. F. Daniell. 7,095. April 4th.

Leads for Electrically Operated Coal-Cutting and other Machines. P. Kirkup, A. P. Stoker, W. Bowman, A. W. Alderson and F. Jones. 8,531. April 20th.

Means for Indicating Leakage in Electric Circuits. A. Sweet. 9,110, May 1st.

Main Distributors for Telephone Exchanges. F. W. Howorth. (Deutsche Telephonwerke, R. Stock & Co. G.m.b.H.) 9,884. May 10th.

Incandescent Electric Lamps and Methods of Making the Same. British Thomson-Houston Co., Ltd. (General Electric Co.) 14,491. July 13th.

Telephones. W. R. Sine and J. S. Rosenthal. 14,808. July 18th.

Device for Strengthening Telephone Currents. F. Oprendek. 19,819. September 30th.

Signalling Apparatus for Single Line Sections of Electric Railways and Tramways. C. D. Abel. (Siemens Schuckertwerke G.m.b.H.) 20,467. October 10th.

Contact Breakers for Ruhmkorff Coils. J. McIntyre. (Date applied for under International Convention, December 8th, 1904.) 21,834. October 26th.

Compensated Single-Phase Alternating Current Commutator Motor. E. Arnold and J. L. La Cour. (Date applied for under International Convention, January 4th, 1904.) 184. January 4th.

Means for Adjusting the Effective Lengths of Flexible Connections for Gas Pendants and Steam or other Fluid or Electrical Conductors. S. Quincey and C. Harrison. 191. January 4th.

Electric Arc Lamps. W. R. Ridings. 210. January 4th.

Means or Apparatus for Periodically Actuating Electric Switches, Valves, Levers, or the like. G. Harrison. (The Albert and J. M. Anderson Manufacturing Co.) 400. January 9th.

Electric Storage Battery Negative Pole Plates. A. J. Boult. (E. W. Smith.) 839. January 16th.

Electric Carrying Lamp. F. G. Bucher. 1,968. February 1st.

Brush Rocking Gear for Dynamos. H. Leitner and H. Hill. 2,341. February 6th.

Method of and Apparatus for Electrically Oxidising Atmospheric Nitrogen. H. H. Lake. (D. Helbig.) 3,346. February 17th.

Sight Magnetic Compasses. A. F. C. Bentley. 3,360. February 17th.

Electric Arc Lamps. A. Eckstein and A. E. Angold. 3,562. February 21st.

Motor Meters for Continuous and Alternating Electric Currents. W. Kostermann. 3,899. February 24th.

Dynamo-Electric Machines. R. Pohl, F. Pohl and Phœnix Dynamo Manufacturing Co., Ltd. 4,375. March 2nd.

Braking Arrangements of Electric Motors. W. H. Scott. 4,967. March 9th.

Electric Switches. A. Bonnella and G. J. Bonnella. 6,271. March 24th.

Process for the Electro-Metallurgical Manufacture of Metals or Alloys Free from Carbon. G. Gin. 8,221. April 18th.

Process for Insulating Electric Wires and Cables. Cie. Francaise de L'Amiante du Cap. (Date applied for under International Convention, May 10th, 1904.) 8,991. April 28th.

Systems of Control for Magnetic Clutch Speed Changing Gears, Applicable more Especially to Self-Propelled Vehicles. British Thomson-Houston Co., Ltd. (General Electric Co.) 9,347. March 3rd.

Insulation for Electric Commutators. M. Meirowsky. 10,949. May 25th.

Electric Heating Apparatus. G. Teuber. 11,407. May 31st.

Means for Joining up Two or More Electric Circuit Wires or like Conductors. Veritys, Ltd., and W. G. Pipkin. 12,205. June 13th.

Sparking Plug for Electric Ignition for Use with Oil, Gas and Petrol Engines. F. J. Scotcher. 15,242. July 25th.